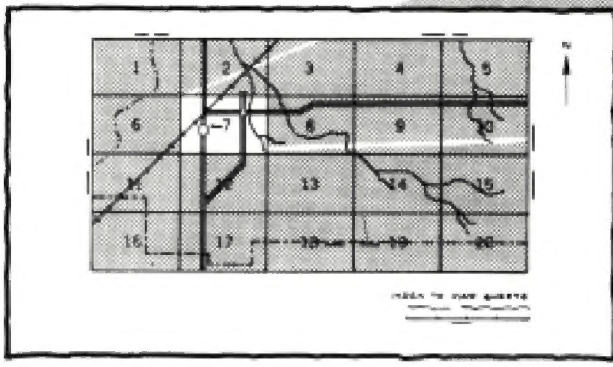
Soil Survey of

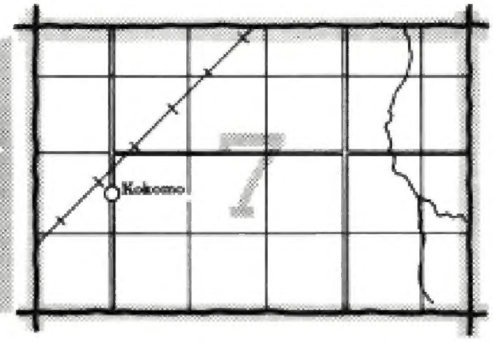
Marshall County, Iowa

United States Department of Agriculture, Soil Conservation Service
in cooperation with the
Iowa Agriculture and Home Economics Experiment Station
Cooperative Extension Service, Iowa State University
and Department of Soil Conservation, State of Iowa

HOW TO USE

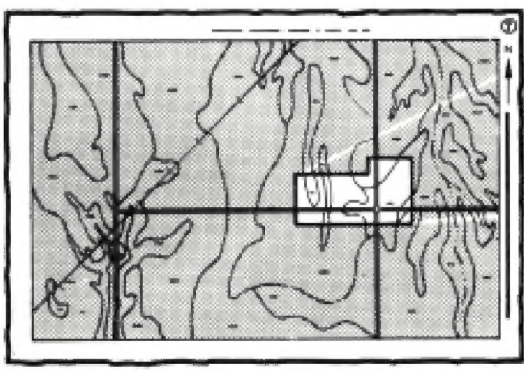
1. Locate your area of interest on the "Index to Map Sheets"

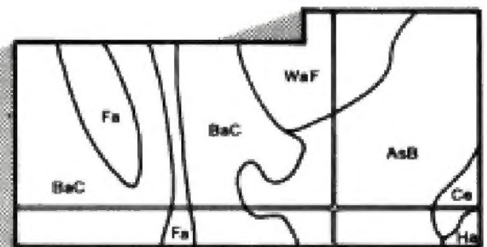




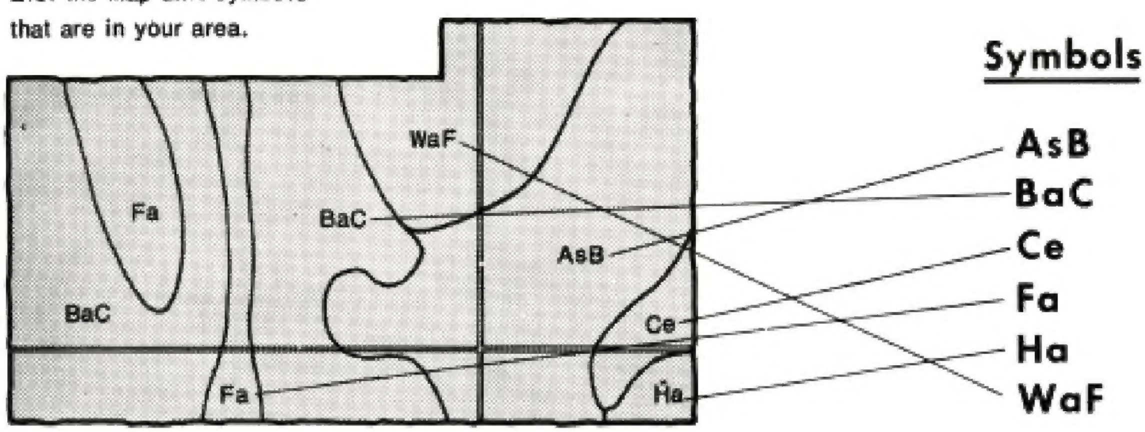
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



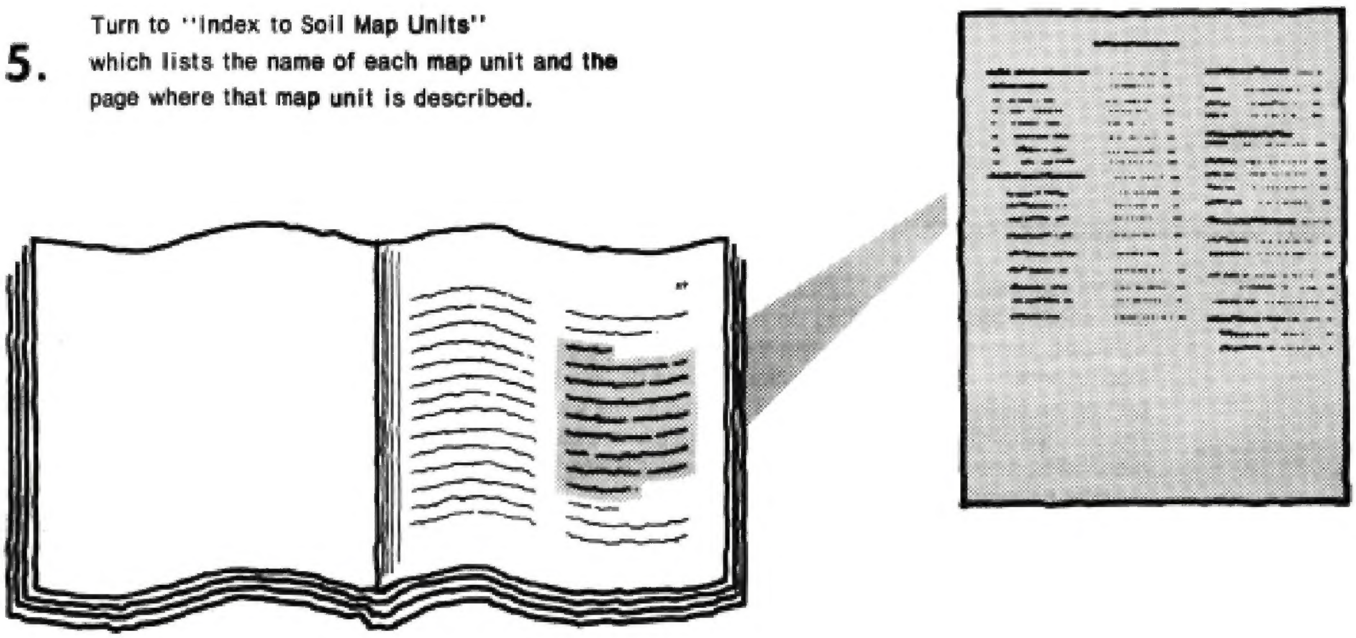


4. List the map unit symbols that are in your area.

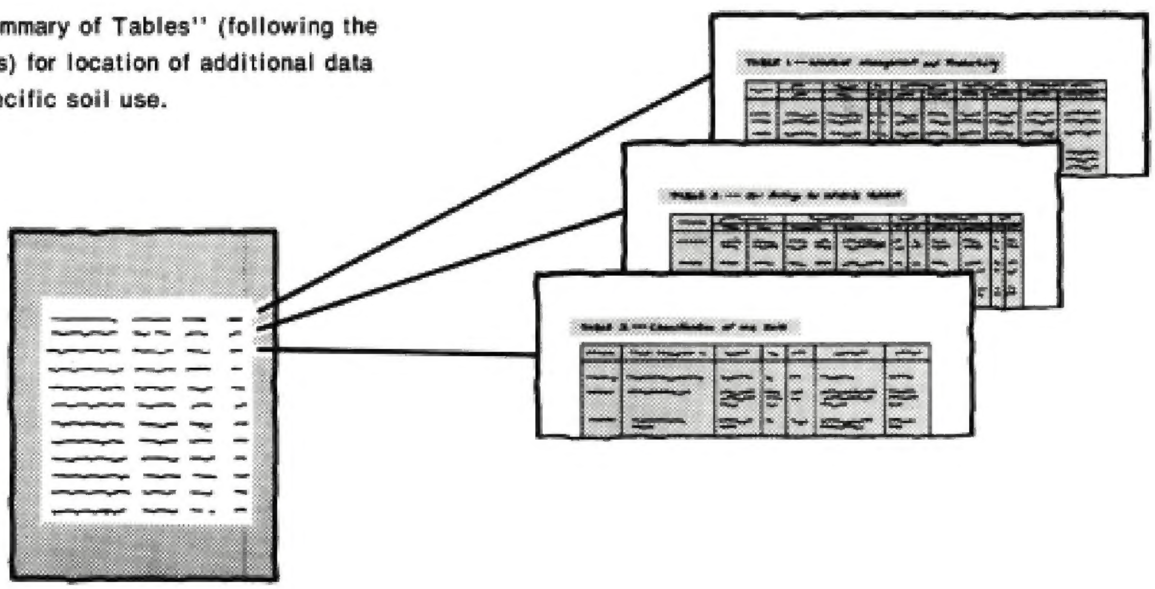


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was performed in the period 1974-1977. Soil names and descriptions were approved in 1978. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1977. This survey was made cooperatively by the Soil Conservation Service, the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa. It is part of the technical assistance furnished to the Marshall County Soil Conservation District. Funds appropriated by Marshall County were used to defray part of the cost of the survey.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

The first soil survey of Marshall County was published in 1921 (*10*). The present survey updates the earlier survey and provides additional information and larger maps that show the soils in greater detail.

Cover: Contour stripcropping and crop rotation help to reduce soil loss in the Killduff-Tama-Shelby association.

contents

soil series

Issued September 1981

index to map units

summary of tables

preface

This soil survey contains information that can be used in land-planning programs in Marshall County, Iowa. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

soil survey of
Marshall County, Iowa

by Douglas B. Oelmann, Soil Conservation Service

fieldwork by Douglas B. Oelmann, Robert C. Russel, Paul V. Sadler, and Norman P. Helzer, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service
in cooperation with
the Iowa Agriculture and Home Economics Experiment Station
the Cooperative Extension Service, Iowa State University
and the Department of Soil Conservation, State of Iowa

MARSHALL COUNTY is in the central part of Iowa (fig. 1). It has a total area of 367,360 acres, or 576 square miles. Marshalltown, the county seat, has a population of 26,506. It is about 40 miles east of Ames and 45 miles northeast of Des Moines.

Farming is the main enterprise in Marshall County, although industry is increasing very rapidly around Marshalltown. The principal crops are corn, soybeans, oats, hay, and pasture. These crops, along with beef cattle, hogs, and dairy products, are the principal sources of income.

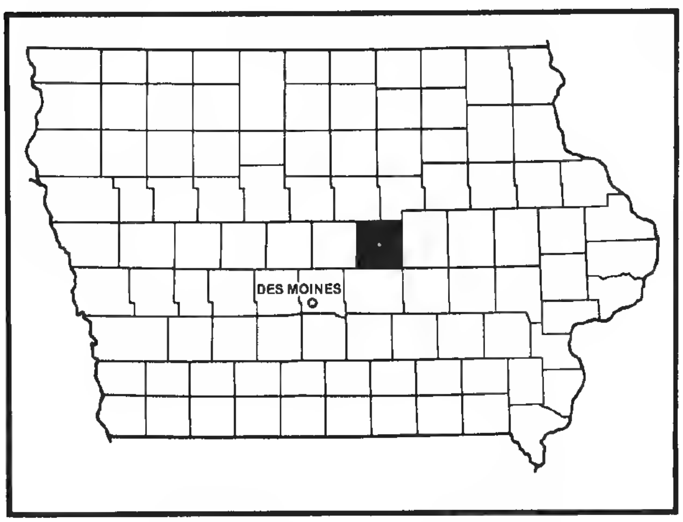


Figure 1.—Location of Marshall County in Iowa.

general nature of the county

This section provides general information about the climate, relief, drainage, history, agriculture, and transportation systems of Marshall County.

climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Marshalltown in the period 1951 to 1973. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 22 degrees F, and the average daily minimum temperature is 13 degrees. The lowest temperature on record, which occurred at Marshalltown on March 1, 1962, is -32 degrees. In summer the average temperature is 72 degrees, and the average daily maximum temperature is 83 degrees. The highest recorded temperature, which occurred at Marshalltown on July 31, 1955, is 104 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 34 inches. Of this, 24

inches, or 70 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 20 inches. The heaviest 1-day rainfall during the period of record was 6.58 inches at Marshalltown on July 14, 1962. Thunderstorms occur on about 50 days each year, and most occur in summer.

Average seasonal snowfall is 33 inches. The greatest snow depth at any one time during the period of record was 24 inches. On an average of 26 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 13 miles per hour, in spring.

relief

The difference in elevation between the lowlands and adjoining uplands is usually 50 to 100 feet. The altitude gradually increases toward the divides, which attain an elevation of more than 200 feet above the water level in the Iowa River. Large areas between drainage systems are mostly nearly level and have only slight undulations of the land surface. The relief is more pronounced in marginal areas near the flood plains of the larger streams.

The highest elevation, 1,147 feet above sea level, is approximately 3 miles northwest of State Center. The lowest point in the county, approximately 850 feet, is where the Iowa River crosses the eastern boundary into Tama County.

drainage

Two major Iowa drainage systems, the Iowa-Cedar and the Skunk, receive runoff water in Marshall County. Nearly 80 percent of the county is drained by the Iowa River and its tributaries. Rock, Burnett, and Asher creeks flow into the Iowa River from the north. Timber, Minerva, Linn, and Honey creeks flow into the Iowa River from the south and west. A very small area of northeastern Marshall County is drained by Wolf Creek eastward toward the Cedar River. The remaining southwestern area is drained by the North Skunk River system.

history

The first settler in the area was Joseph C. Davidson in spring of 1846. At that time the area was part of the Iowa Territory. Settlement of the county began in 1848 when a group established a settlement near the present site of LeGrand (*22*).

Marshall County was organized in 1849, under the management of Joseph M. Ferguson, and was named for John Marshall, 4th Chief Justice of the United States (*17*).

The first county seat was the town of Marietta in 1851. The county seat was later moved to the town of Marshall in 1859 after a bitter debate. Marshall was renamed Marshalltown in 1862.

During the 1850's, more than a dozen roads were established through Marshall County by order of the General Assembly of Iowa. The first bridge across the Iowa River in Marshall County was completed in 1857. Stage coach services were established through the county in 1857. Telegraph service was brought to Marshalltown by 1862 (*17*).

The first railroad in the county was completed to Marshalltown in 1863. Soon railroads were built to many parts of the county to provide outlets for farm products. By 1912, there was over 148 miles of track in Marshall County (*3*).

The first census, in 1850, showed a population of 338. The next half century was the period of greatest growth. The greatest percentage increase occurred from 1850 to 1860 (1,680 percent). The greatest numerical increase took place from 1860 to 1870 (11,561). The most stable period of population was 1940 to 1950 (0.6 percent increase).

agriculture

The recent trend in Marshall County has been a gradual decrease in the number of farms. At the same time, the average age of the farm operators has dropped.

Over sixty percent of the population of Marshall County lives in Marshalltown. Farm population represented 15 percent of the county population in 1970.

Corn and soybeans are the main row crops. In 1976, there were 1,380 farms averaging 254 acres. Agriculture is of prime importance to Marshall County and continues to be a vital part of the total economy. It provides a livelihood, not only for farmers, but also for those engaged in business, professions, finance, and many other agri-business related activities.

Farming in Marshall County is becoming more specialized in livestock production with more farmers producing only one class of livestock. There has been an increase in the number of total confinement livestock systems, primarily in swine production.

Marshall County has a total land area of 367,360 acres. Of this, approximately 290,000 acres are tillable. Although fewer and larger farms account for a part of the overall increased production, increased efficiency also contributes to farm output. Total cash receipts for farms in the county have been considerably above the average for the state of Iowa.

Total crop and livestock production expenses for any one year could be near one-half of the total cash receipts. Although this figure is highly variable, farm production expenses represent a sizable portion of the

total economy. Feed, seed, fertilizer, chemicals, fuel, oil, machinery, and other products are mostly purchased locally. The sale of livestock has an ever greater economic impact to the county and surrounding community.

transportation

Three major highways are centrally located in the county. U.S. Highway 30, which traverses the county east and west, intersects State Highway 14, which traverses the county north and south, at Marshalltown. State Highway 330 begins at Marshalltown and traverses the county diagonally toward Des Moines to the southwest. Hard surface state or county roads connect these highways to all of the smaller communities in the county. All farms are on farm-to-market roads of crushed limestone or gravel. Major county roads are well distributed over the county.

There are several railway branches from all directions intersecting in Marshalltown. There is also a railway that traverses east and west in the southern part of the county.

Bus transportation is available in Marshalltown in all directions. Marshalltown has an airport three miles north of the city limits. Motor freight lines serve every trading center in the county.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, woodland managers, engineers, planners, developers and builders, home buyers, and others.

general soil map units

The general soil map at the back of this publication shows broad areas, called soil associations, that have a distinctive pattern of soils, relief, and drainage. Each soil association on the general soil map is a unique natural landscape. Typically, a soil association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other associations but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

1. Colo-Lawson-Zook association

Nearly level, poorly drained and somewhat poorly drained, silty soils formed in alluvium; on bottom lands and alluvial fans

This association consists of nearly level soils on flood plains and fans along major streams and in river valleys. These soils are subject to flooding. In places near the natural water course, the flood plains are severely dissected, and water stands in old channels.

This association makes up 10 percent of the county. It is about 29 percent Colo soils, 13 percent Lawson soils, 10 percent Zook soils, and 48 percent soils of minor extent (fig. 2).

Colo soils, on flood plains and alluvial fans, are nearly level and are poorly drained. Typically, the surface layer is black silty clay loam about 11 inches thick. The subsurface layer is black silty clay loam about 26 inches thick. The next layer is very dark gray silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is light brownish gray silty clay loam.

Lawson soils, on first and second bottoms, are nearly level and are somewhat poorly drained. Typically, the surface layer is black silty clay loam about 6 inches thick. The subsurface layer is black and very dark brown silty clay loam in the upper part and very dark grayish brown silty clay loam in the lower part. The substratum to a depth of about 60 inches is dark grayish brown silty clay loam.

Zook soils, on low flood plains, are nearly level and are poorly drained. Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is black silty clay loam and silty clay about 31 inches thick. The subsoil to a depth of about 60 inches is very dark gray and grayish brown, friable silty clay loam.

Soils of minor extent in this association are the Ackmore, Hanlon, Lawler, Nevin, Nodaway, Saude, and Wiota soils. The poorly drained and somewhat poorly drained Ackmore soils and moderately well drained Nodaway and Hanlon soils are on broad flood plains and bottom lands near the natural stream channel. In addition, Ackmore and Nodaway soils are on alluvial fans near tributaries. The somewhat poorly drained Lawler soils and well drained Saude soils are on stream benches and outwash plains. The somewhat poorly drained Nevin soils are on high bottoms and low stream benches. The well drained and moderately well drained Wiota soils are on stream benches.

Most areas of this association are used for cultivated crops. Channeled and dissected areas of the flood plain are used for pasture and trees. The main enterprise is growing cash grain crops. The soils are well suited to cultivated crops if they are adequately drained and protected from flooding. They are poorly suited to building site development and sanitary facilities.

Corn, soybeans, oats, hay, and pasture grow well on the soils of this association. The organic matter content and the available water capacity of these soils are high. The main concerns of management are improving drainage and protecting the soils from flooding. These soils can be drained by tile and surface drains if adequate outlets are available. Diversions, levees, and channel improvements help to provide flood protection and control runoff from adjacent areas.

2. Muscatine-Tama-Garwin association

Nearly level and gently sloping, somewhat poorly drained, well drained, and poorly drained, silty soils formed in loess; on uplands

This association consists of wide areas of nearly level soils on divides and gently sloping soils on side slopes. The landscape is mostly gently undulating and undulating.

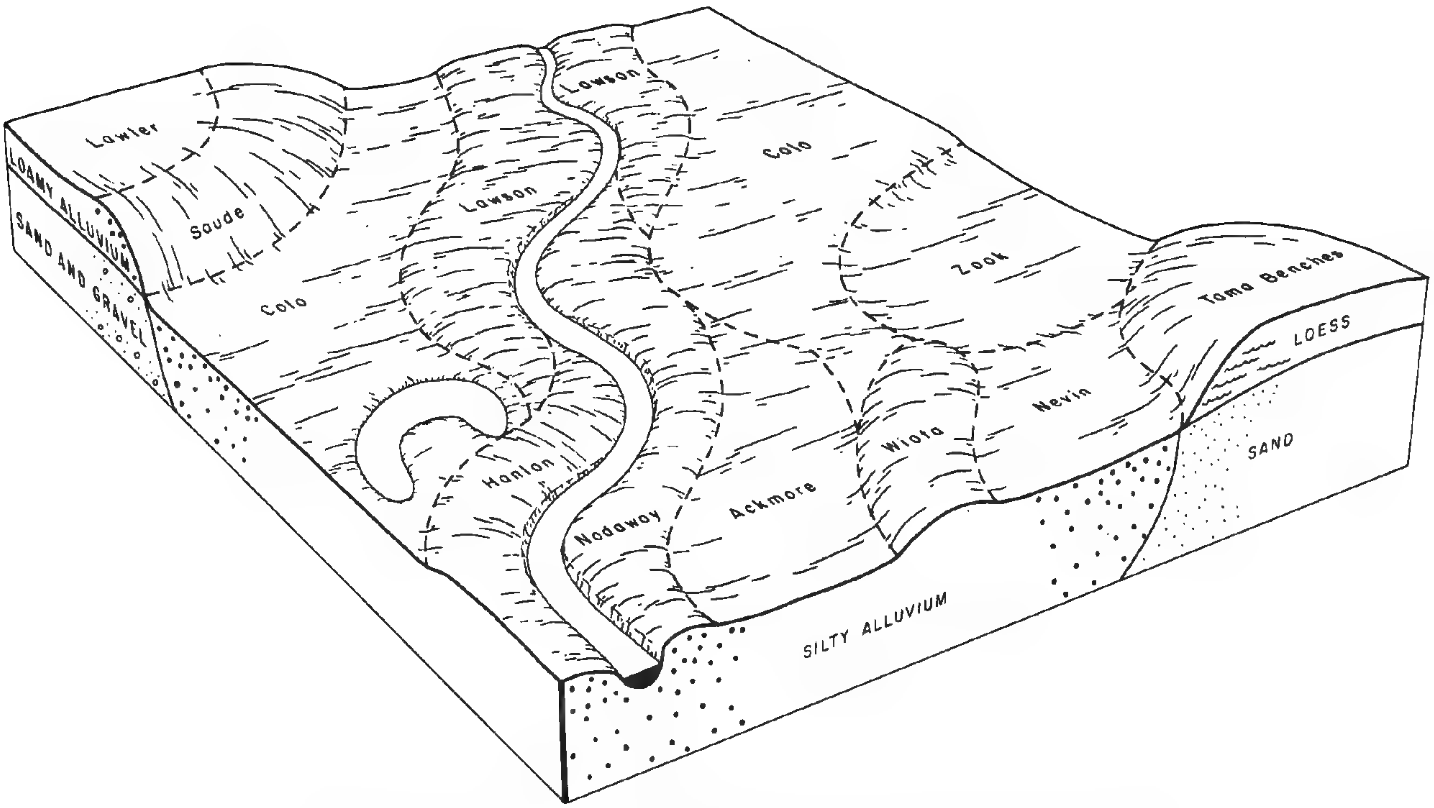


Figure 2.—Typical pattern of soils and parent material in the Colo-Lawson-Zook soil association.

This association makes up about 21 percent of the county. It is about 43 percent Muscatine soils, 38 percent Tama soils, 13 percent Garwin soils, and 6 percent soils of minor extent.

Muscatine soils, on moderately wide divides, are very gently sloping and are somewhat poorly drained. Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is black and very dark brown silty clay loam about 10 inches thick. The subsoil is silty clay loam about 27 inches thick. It is very dark grayish brown and dark grayish brown in the upper part and mottled grayish brown and light olive brown in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay loam.

Tama soils, on broad convex ridgetops and side slopes, are nearly level and gently sloping and are well drained. Typically, the surface layer is very dark brown silty clay loam about 7 inches thick. The subsurface layer is very dark brown and very dark grayish brown silty clay loam about 9 inches thick. The subsoil is friable silty clay loam about 31 inches thick. It is brown in the upper part, yellowish brown in the middle part, and dark yellowish brown and yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled silty clay loam.

Garwin soils, on wide divides and concave heads of drainageways, are nearly level and are poorly drained. Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black and very dark gray silty clay loam about 9 inches thick. The subsoil is friable silty clay loam about 26 inches thick. It is dark gray and gray in the upper part and mottled olive gray in the lower part. The substratum to a depth of about 60 inches is light olive gray, mottled silty clay loam.

The soils of minor extent in this association are the Colo, Ely, Harpster, and Sperry soils. The poorly drained Colo soils are in upland drainageways. The somewhat poorly drained Ely soils are on foot slopes. The poorly drained, calcareous Harpster soils are on wide divides and at the heads of drainageways. The very poorly drained Sperry soils are in slight depressions on wide divides.

Most areas of this association are used for row crops (fig. 3). The main enterprise is growing cash grain crops. These soils are well suited to all cultivated crops commonly grown in the county.

Corn, soybeans, oats, and hay grow well on the soils of this association. The available water capacity is high to very high. The organic matter content of these soils is moderate to high. The main concerns of management are controlling erosion and improving drainage.

3. Clarion-Nicollet-Webster association

Nearly level to moderately steep, well drained, somewhat poorly drained, and poorly drained, loamy and silty soils formed in glacial till; on uplands

This association consists of nearly level to moderately steep soils on the Cary end and ground moraines. The moraines are undulating to hilly. In places, this association has a well developed drainage pattern.

This association makes up 9 percent of the county. It is about 34 percent Clarion soils, 16 percent Nicollet soils, 11 percent Webster soils, and 39 percent soils of minor extent (fig. 4).

Clarion soils, on convex upland slopes and on end and ground moraines, are gently sloping to moderately steep and are well drained. Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 7 inches thick. The subsoil is friable loam about 23 inches thick. It is dark brown in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam.

Nicollet soils, on ground moraines that have low relief, are very gently sloping and are somewhat poorly drained. Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black and very dark gray loam about 12 inches thick. The subsoil is friable clay loam about 13 inches thick. It is dark grayish brown in the upper and middle parts and mottled dark grayish brown in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled loam.

Webster soils, on ground moraines are nearly level and are poorly drained. Typically, the surface layer is black silty clay loam about 5 inches thick. The subsurface layer is black and very dark gray silty clay loam about 15 inches thick. The subsoil is friable silty clay loam about 19 inches thick. It is dark gray in the upper part, dark grayish brown in the middle part, and mottled grayish brown in the lower part. The substratum to a depth of about 60 inches is grayish brown loam and olive gray sandy loam.

The soils of minor extent in this association are the Canisteo, Coland, Harps, Lester, Okoboji, Storden, and Terril soils. The poorly drained Canisteo, Harps, and

Figure 3.—Conservation tillage protects soils in the Muscatine-Tama-Garwin soil association from erosion by wind and water.

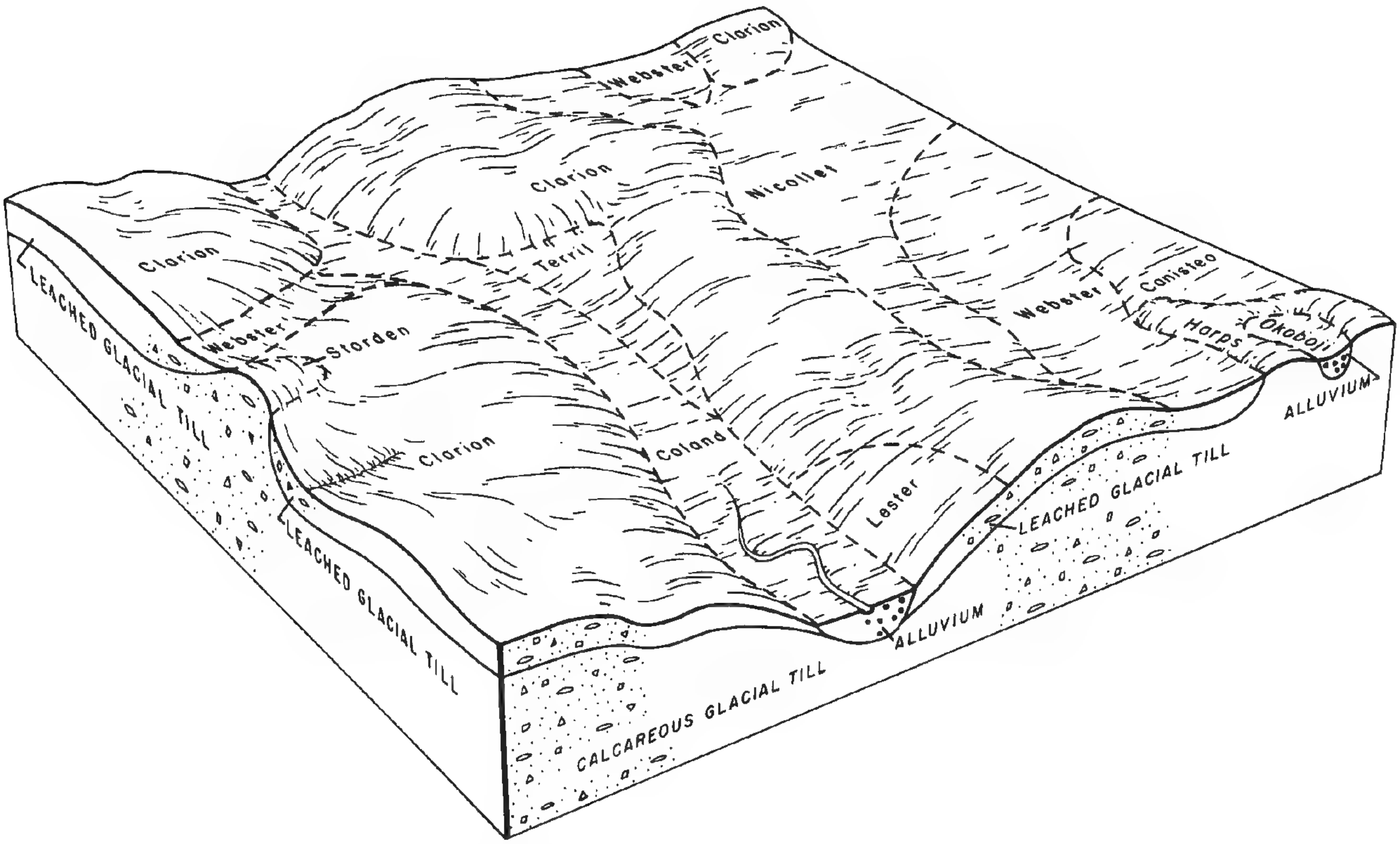


Figure 4.—Typical pattern of soils and parent material in the Clarion-Nicollet-Webster soil association.

Okoboji soils are on undissected till plains. The calcareous Canisteo and Harps soils are on rims of depressions and are closely intermingled with Okoboji and Webster soils. The very poorly drained Okoboji soils are in depressional areas that were formerly lakes or ponds. The poorly drained Coland soils are in drainageways. The Lester soils and calcareous Storden soils are on the convex end moraine. The moderately well drained Terril soils are on foot slopes.

Most areas of this association are used for corn and soybeans, but a few moderately steep areas are used for hay and pasture. The main enterprise is growing cash grain crops. The suitability of these soils for cultivated crops, hay, pasture, and building site development ranges from well suited to poorly suited.

Corn, soybeans, hay, and pasture grow well on the soils of this association. The organic matter content of these soils is moderate to low. The available water capacity is high. The concerns of management are controlling wind and water erosion, improving drainage, and maintaining fertility.

4. Tama association

Moderately sloping and strongly sloping, well drained, silty soils formed in loess; on uplands

This association consists of moderately sloping soils on ridgetops and strongly sloping soils on side slopes. The landscape is gently rolling to rolling. A large part of this association has a well developed drainage pattern.

This association makes up 23 percent of the county. It is about 78 percent Tama soils and 22 percent soils of minor extent.

Tama soils, on convex upland slopes, are moderately sloping to strongly sloping and are well drained. Typically, the surface layer is very dark brown silty clay loam about 7 inches thick. The subsurface layer is very dark brown and very dark grayish brown silty clay loam about 9 inches thick. The subsoil is friable silty clay loam about 31 inches thick. It is brown in the upper part and yellowish brown and dark yellowish brown loam in the lower part. The substratum to a depth of about 60 inches is brown, mottled silty clay loam.

The soils of minor extent in this association are the Ackmore, Colo, Dinsdale, Ely, and Liscomb soils. The somewhat poorly drained and poorly drained Ackmore soils and poorly drained Colo soils are in drainageways. The well drained and moderately well drained Dinsdale soils are on side slopes along drainageways. The somewhat poorly drained Ely soils are on foot slopes. The well drained and moderately well drained Liscomb soils are on the lower part of side slopes. They are moderately steep in places.

Most areas of this association are used for row crops, but a few strongly sloping, eroded soils are used for hay and pasture. The main enterprise is growing cash grain crops. These soils are well suited or moderately suited to cultivated crops. Suitability for building site development is fair to good.

Corn, soybeans, hay, and pasture grow well on the soils of this association. The available water capacity is high, and the organic matter content is moderate to low. The main concerns of management are controlling water erosion and maintaining fertility.

5. Killduff-Tama-Shelby association

Moderately sloping to steep, well drained and moderately well drained, silty and loamy soils formed in loess and glacial till; on uplands

This association consists of moderately sloping and strongly sloping soils on ridgetops and coves and strongly sloping to steep soils on side slopes. The landscape is gently rolling to hilly. This association has a well developed drainage pattern.

This association makes up 30 percent of the county. It is about 39 percent Killduff soils, 33 percent Tama soils, 11 percent Shelby soils, and 17 percent soils of minor extent (fig. 5).

Killduff soils, on convex side slopes and head slopes of drainageways, are moderately sloping to moderately steep and are well drained and moderately well drained. Typically, the surface layer is very dark grayish brown and brown silty clay loam about 7 inches thick. The subsoil is friable silty clay loam about 31 inches thick. It

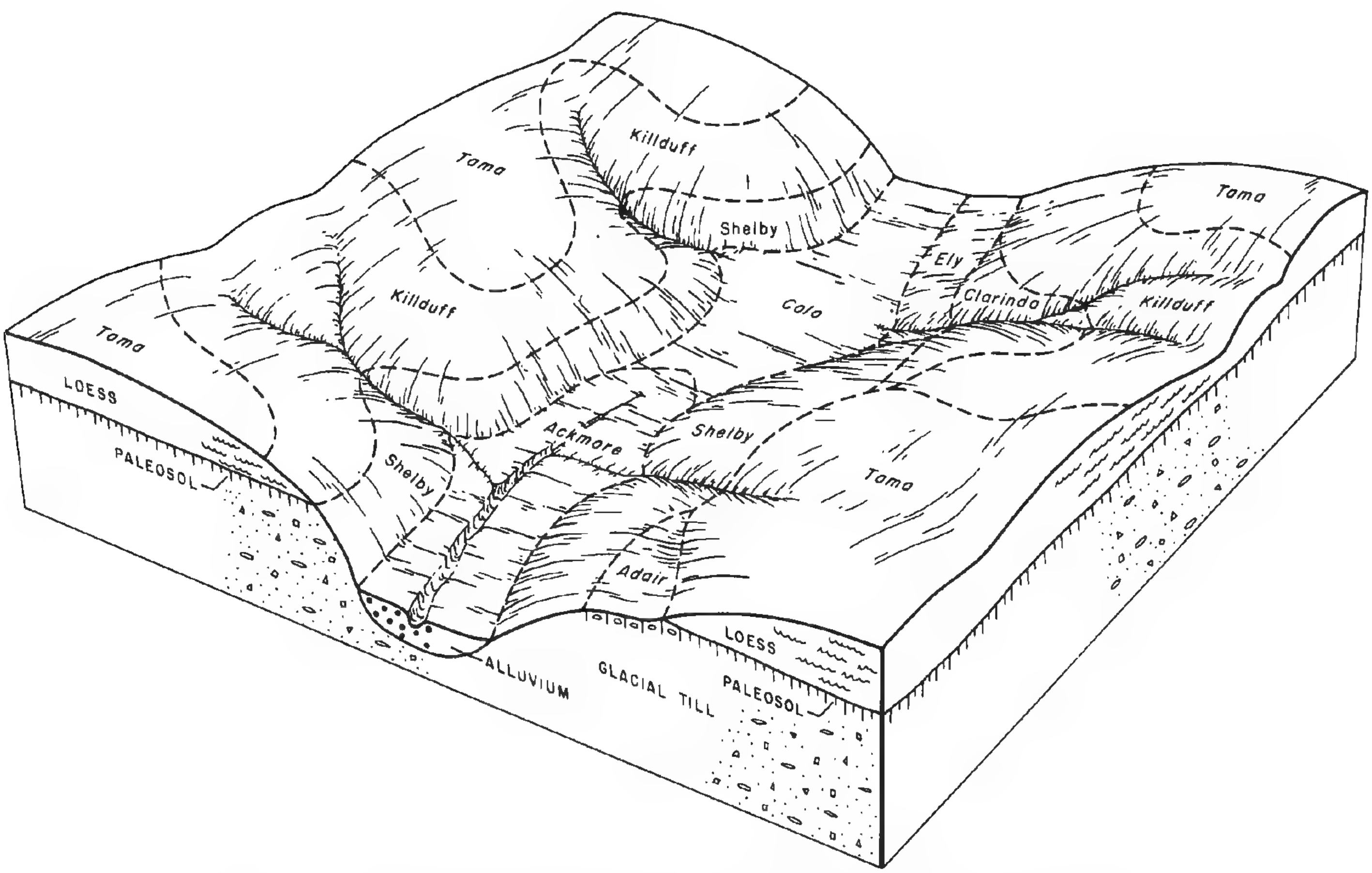


Figure 5.—Typical pattern of soils and parent material in the Killduff-Tama-Shelby soil association.

is brown in the upper part and mottled brown and grayish brown in the lower part. The substratum to a depth of about 60 inches is light brownish gray, mottled silt loam.

Tama soils, on convex ridgetops, nose slopes, and side slopes, are moderately sloping to moderately steep and are well drained. Typically, the surface layer is very dark brown silty clay loam about 7 inches thick. The subsurface layer is very dark brown and very dark grayish brown silty clay loam about 9 inches thick. The subsoil is friable silty clay loam about 31 inches thick. It is brown in the upper part, yellowish brown in the middle part, and dark yellowish brown and yellowish brown in the lower part. The substratum to a depth of about 60 inches is brown silty clay loam. In places, the surface layer is about 6 inches thick and has some mixing of dark brown and brown subsoil.

Shelby soils, on convex side slopes and narrow nose slopes, are strongly sloping to steep and are well drained and moderately well drained. Typically, the surface layer is mixed very dark grayish brown, brown, and dark brown loam about 7 inches thick. The subsoil is firm clay loam about 38 inches thick. It is dark yellowish brown in the upper part and mottled yellowish brown and grayish brown in the lower part. The substratum to a depth of about 60 inches is grayish brown and yellowish brown, mottled clay loam.

The soils of minor extent in this association are the Ackmore, Adair, Clarinda, Colo, Ely, and Judson soils. The somewhat poorly drained and poorly drained Ackmore soils and poorly drained Colo soils are in drainageways. The poorly drained Clarinda soils are on convex side slopes and coves at the heads of drainageways. The somewhat poorly drained Ely soils and the well drained and moderately well drained Judson soils are on foot slopes. The moderately well drained and somewhat poorly drained Adair soils are on convex side slopes, nose slopes, and shoulders of narrow ridgetops. The seepy Adair and Clarinda soils are at lower elevations than the Killduff and Tama soils.

Most areas of this association are used for corn, but soybeans are grown on many gently rolling areas. Some areas, including eroded and steep places, are used for hay and pasture. The main enterprises are growing cash grain crops and feeding swine and beef cattle. The suitability of these soils for cultivated crops, hay, pasture, and building site development ranges from poor to good.

Corn, soybeans, oats, hay, and pasture grow well on the gently rolling and rolling soils of this association (fig. 6). These crops do not grow well on the hilly and steep soils. The organic matter content of these soils is moderate to very low. The available water capacity is high. The main concerns of management are controlling water erosion, preventing the formation of gullies, and maintaining fertility.

6. Downs-Gara association

Gently sloping to steep, well drained and moderately well drained, silty and loamy soils formed in loess and glacial till; on uplands

This association consists of gently sloping soils on ridgetops and broad divides and steep soils on dissected upland side slopes near major streams and river valleys. The landscape is undulating to very hilly. This association has a well developed drainage pattern.

This association makes up 5 percent of the county. It is about 66 percent Downs soils, 10 percent Gara soils, and 24 percent soils of minor extent (fig. 7).

Downs soils, on ridgetops and side slopes, are gently sloping to moderately steep and are well drained. Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is dark grayish brown and brown silt loam about 4 inches thick. The subsoil is friable silty clay loam about 35 inches thick. It is brown and dark yellowish brown in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is brown, light brownish gray, and strong brown, mottled silty clay loam.

Gara soils, on dissected upland side slopes, are strongly sloping to steep and are moderately well drained and well drained. Typically, the surface layer is very dark grayish brown loam about 6 inches thick. The subsurface layer is dark grayish brown loam about 5 inches thick. The subsoil is firm clay loam about 36 inches thick. It is dark yellowish brown and yellowish brown in the upper part and mottled yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled clay loam.

The soils of minor extent in this association are the Ackmore, Colo, Fayette, and Lindley soils. The somewhat poorly drained and poorly drained Ackmore soils and poorly drained Colo soils are in drainageways. The well drained Fayette soils, which are lower in organic matter content than Downs soils, are on upland ridgetops and side slopes. The well drained Lindley soils are at lower elevations than Downs and Fayette soils. The Lindley soils are on convex ridgetops and dissected upland side slopes.

Most areas of this association are used for row crops, small grain, hay, and pasture. Most of the upland wooded areas in the county are in this association (fig. 8). The main enterprises are growing cash grain crops and raising cow-calf herds. The suitability of these soils for cultivated crops, hay, pasture, trees, building site development, and habitat for woodland wildlife ranges from poor to good.

Corn, soybeans, oats, hay, pasture, and trees grow moderately well on the gently sloping and moderately sloping soils in this association. These crops are generally not suited to the steep soils. The organic matter content of these soils is moderate to very low. The main concerns of management are controlling water erosion, preventing the formation of gullies, and maintaining fertility.

Figure 6.—Conservation tillage and contour stripcropping help to reduce soil loss in the Killduff-Tama-Shelby soil association.

7. Dickinson-Sparta association

Gently sloping to strongly sloping, well drained to excessively drained, loamy and sandy soils formed in eolian sand and wind-reworked alluvium; on uplands and benches

This association consists of gently sloping to strongly sloping soils on convex ridgetops, upland side slopes, crests of escarpments, and dunes on stream benches. The sand dunes are undulating to rolling. In most places, this association is on uplands and stream benches southeast of major streams and rivers.

This association makes up 2 percent of the county. It is about 40 percent Dickinson soils, 25 percent Sparta soils, and 35 percent soils of minor extent.

Dickinson soils, on convex slopes and dunes, are gently sloping to strongly sloping and are well drained and somewhat excessively drained. Typically, the surface layer is black fine sandy loam about 5 inches thick. The subsurface layer is black and very dark grayish brown fine sandy loam about 13 inches thick. The subsoil is about 30 inches thick. It is very dark grayish brown, friable fine sandy loam in the upper part; brown, friable fine sandy loam in the middle part; and brown and dark yellowish brown, very friable loamy fine sand in the lower part. The substratum to a depth of about 60 inches is brown loamy sand.

Sparta soils, on convex slopes and dunes, are gently sloping to strongly sloping and are excessively drained. Typically, the surface layer is very dark brown loamy fine sand about 7 inches thick. The subsurface layer is very dark grayish brown loamy fine sand about 12 inches thick. The subsoil is dark yellowish brown, very friable

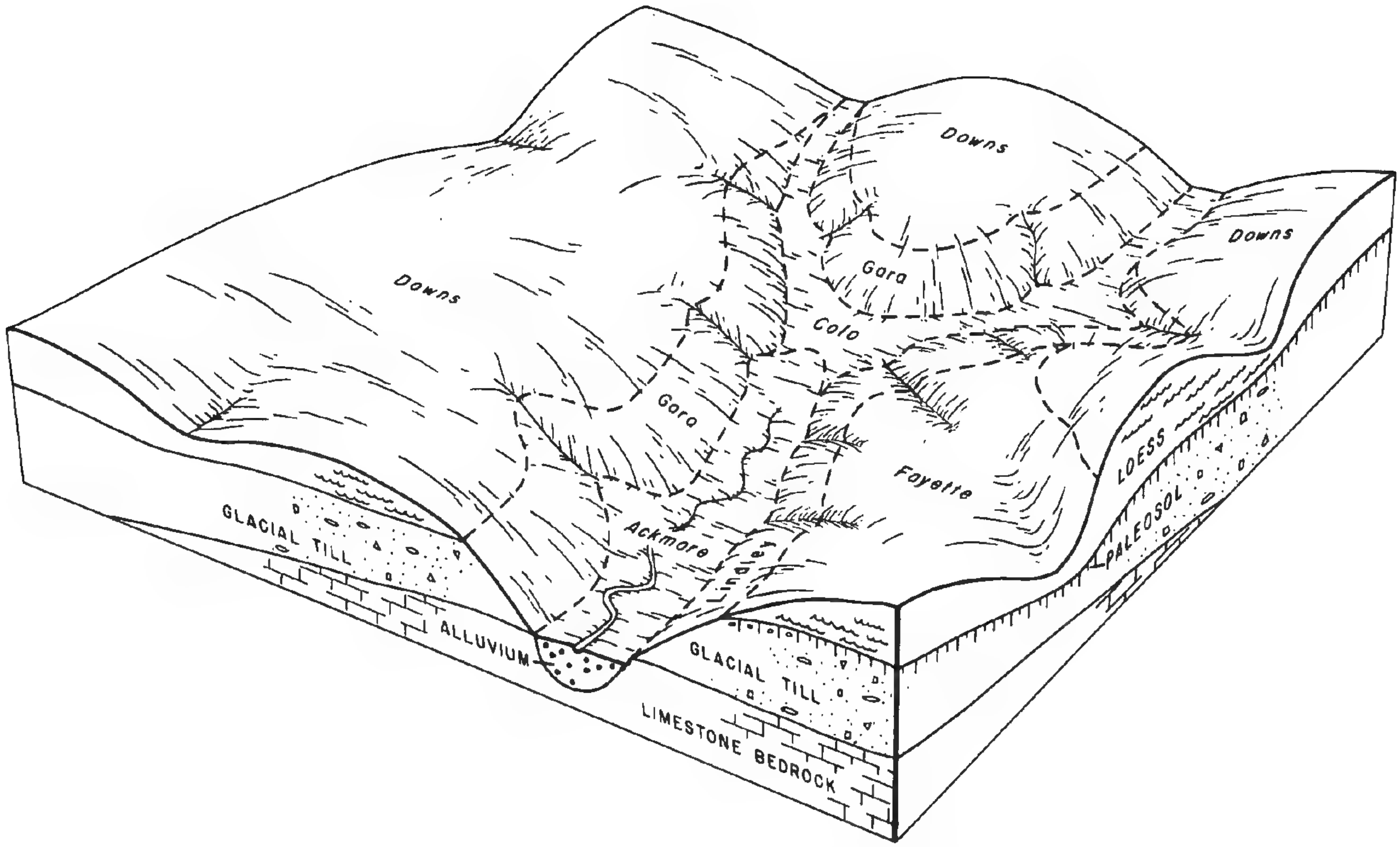


Figure 7.—Typical pattern of soils and parent material in the Downs-Gara soil association.

loamy fine sand about 14 inches thick. The substratum to a depth of about 60 inches is yellowish brown sand.

The soils of minor extent in this association are the Chelsea, Colo, and Tama soils. The excessively drained Chelsea soils are on dunes, convex ridgetops, upland side slopes, and crests of escarpments. The poorly drained Colo soils are in drainageways. The well drained and moderately well drained Tama soils are closely intermingled with areas of the Dickinson and Sparta soils.

Most areas of this association are used for hay, pasture, and cultivated crops. The main enterprises are growing of cash crops and raising cow-calf herds. These soils are poorly suited to cultivated crops, and they are poorly suited to moderately suited to hay, pasture, and trees. Suitability for building site development is poor to fair.

Corn, soybeans, and oats do not grow well on soils of this association. The available water capacity is low, and the soils are droughty. Vegetation is difficult to establish, and wind erosion is a hazard. Some places in this association are potential sources of fine sand.

Figure 8.—Typical areas of the Downs-Gara soil association.

detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Tama silty clay loam, 2 to 5 percent slopes, is one of several phases in the Tama series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Colo-Ely complex, 2 to 5 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, sand and gravel, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

soil descriptions

5B—Ackmore-Colo complex, 2 to 5 percent slopes. This map unit consists of gently sloping, somewhat poorly drained and poorly drained soils on toe slopes, alluvial fans, and narrow flood plains. Many areas are along small streams on uplands. These soils are subject to frequent flooding. Individual areas are long and narrow and range from 10 to more than 100 acres.

Mapped areas are about 50 percent Ackmore soil and 30 to 45 percent Colo soil. The Ackmore soil is near stream channels. The poorly drained Colo soil borders the Ackmore soil in most places. Areas of these soils are so small that it is not practical to separate them in mapping.

Typically, the Ackmore soil has a surface layer of very dark gray and very dark grayish brown silt loam about 7 inches thick. The substratum is stratified, very dark gray, very dark grayish brown, and dark grayish brown silt loam about 20 inches thick. Below the substratum to a depth of about 60 inches is a buried soil of black silty clay loam. In some areas, the combined thickness of the silt loam surface layer and substratum is less than 18 inches.

Typically, the Colo soil has a surface layer of black silty clay loam about 11 inches thick. The subsurface layer is black silty clay loam about 26 inches thick. The next layer is very dark gray silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is light brownish gray silty clay loam. In places, the combined thickness of the surface layer and subsurface layer is less than 36 inches. In places, there is a subsoil of dark grayish brown silty clay loam.

Included with these soils in mapping, and making up 5 to 10 percent of the map unit, are small areas of well drained and moderately well drained Judson soils.

Judson soils are on foot slopes and not subject to flooding.

Permeability of the Ackmore soil and Colo soil is moderate. The available water capacity is very high in the Ackmore soil and high in the Colo soil. Surface runoff is slow or medium for the Ackmore soil and slow for the Colo soil. Both soils have a seasonal high water table. The content of organic matter is about 1 to 3 percent in the surface layer of the Ackmore soil and 5 to 7 percent in the surface layer of the Colo soil. Typically, reaction is neutral to medium acid in the solum of both soils. The available phosphorus in the substratum is low for the Ackmore soil and medium for the Colo soil. The substratum of both soils is very low in available potassium. Tilth of the surface layer is good for the Ackmore soil and fair for the Colo soil.

Most areas of these soils are cultivated. These soils are well suited to cultivated crops, hay, and pasture and poorly suited to most sanitary facilities and building site development.

These soils are well suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. Most areas of this complex are suited to intensive row cropping if drained and adequately protected from flooding. Diversions, levees, and channel improvements can provide flood protection and divert runoff from adjacent areas. Artificial drainage helps to improve timeliness of operations and maintain tilth.

The soils in this complex are in capability subclass IIw.

6—Okoboji silty clay loam, 0 to 1 percent slopes. This level, very poorly drained soil is in concave depressions on uplands. Areas of this soil are subject to ponding. Individual areas are rounded and range from 2 to 10 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is silty clay loam about 20 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is very dark gray, olive, and gray, mottled, friable silty clay loam about 16 inches thick. The substratum to a depth of about 60 inches is gray silty clay loam that has olive mottles. In places, the surface layer is calcareous.

Included with this soil in mapping are a few small areas of Harps soils on rims of depressions. These Harps soils are calcareous throughout and have a very high concentration of carbonates near the surface. These soils make up 5 percent of the map unit.

Permeability of this Okoboji soil is moderately slow, and surface runoff is slow to ponded. This soil has a seasonal high water table. The available water capacity is very high. The surface layer is neutral or mildly alkaline. The content of organic matter is about 9 to 11 percent in the surface layer. The available phosphorus in the subsoil is very low, and the available potassium is low to very low. This soil has fair tilth. However, the soil dries out more slowly than adjacent soils, and tillage is often delayed.

Most areas of this soil are cultivated. This soil is moderately suited to cultivated crops, hay, and pasture if artificially drained. It is generally unsuitable for sanitary facilities and building site development.

This soil is moderately suited to corn, soybeans, and small grain. The soil is very wet, and water tends to pond in many areas in the spring or during heavy rains, making surface intakes and tile drains desirable. Crops drown out in many places, and winter killing of legumes is a hazard. This soil is slow to warm in the spring and is subject to damage by early frost. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, helps to prevent excessive soil loss from wind erosion. Returning crop residue helps to maintain good tilth and increase water infiltration.

If used for pasture, overgrazing or grazing when the soil is wet causes surface compaction and decreases infiltration. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Okoboji soil is in capability subclass IIIw.

7—Wiota silty clay loam, 1 to 3 percent slopes. This very gently sloping, well drained and moderately well drained soil is on convex slopes of low stream benches that lie a few feet above the flood plains. Areas of this soil are subject to rare flooding. Individual areas are irregular in shape and range from 5 to 30 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is silty clay loam about 18 inches thick. It is very dark gray in the upper part and very dark grayish brown and dark brown in the lower part. The subsoil is brown, friable silty clay loam about 23 inches thick. The substratum to a depth of about 60 inches is yellowish brown silty clay loam. In places, the subsoil is grayish brown, friable silty clay loam.

Permeability of this soil is moderate, and surface runoff is medium. The available water capacity is high. The surface layer has 3 to 4 percent content of organic matter. The surface layer and the subsoil are slightly acid. The available phosphorus in the subsoil is very low, and the available potassium is low. This soil has fair tilth.

Areas of this soil are cultivated and used intensively for row crops. The soil is well suited to cultivated crops, hay, and pasture. It is moderately suited to sanitary facilities and poorly suited to building site development.

This soil is well suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. Individual areas of this soil that are small in size are cropped with adjacent soils. This soil is higher than the adjacent first bottom lands and is rarely flooded. Areas adjacent to foot slopes receive runoff in places. Diversions help to prevent runoff from adjacent side slopes.

This soil is well suited to hay and pasture if they are used in a cropping sequence with alfalfa as the main plant. Both warm and cool season grasses should be

included in pasture rotation systems. Grasses and legumes increase water infiltration, protect the soil from wind erosion, and improve tilth. Overgrazing or grazing when the soil is wet causes surface compaction and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Wiota soil is in capability class I.

8B—Judson silty clay loam, 2 to 5 percent slopes. This gently sloping, well drained and moderately well drained soil is on foot slopes and convex alluvial fans. Individual areas are long and narrow. Areas on foot slopes range from 5 to 15 acres, and areas on alluvial fans are 5 to 10 acres.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown and very dark brown silty clay loam about 26 inches thick. The subsoil is friable silty clay loam about 28 inches thick. It is dark brown in the upper part and dark yellowish brown in the lower part.

Included with this soil in mapping are small areas of Ely and Colo soils. The Ely and Colo soils are more poorly drained and are adjacent to waterways that dissect the Judson map unit. These soils make up about 5 percent of the map unit.

Permeability of this Judson soil is moderate, and surface runoff is medium. The available water capacity is very high. The content of organic matter in the surface layer is 3.5 to 4.5 percent. Typically, the surface layer is slightly acid or neutral. The subsoil is slightly acid or medium acid. The available phosphorus and available potassium in the subsoil are low. This soil has fair tilth.

Most areas of this soil are used as cropland, but some areas are in pasture. This soil is well suited to cultivated crops, hay, pasture, and trees, but in places it is associated with areas that are subject to runoff and flooding. This soil is well suited to septic tank filter fields and moderately suited to building site development.

This soil is well suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. Individual areas are generally small and are cropped with adjacent soils. Some areas are subject to runoff from upland side slopes. This causes siltation or erosion, and in places runoff water concentrates and causes gullying. Diversion terraces help to divert runoff from adjacent upland side slopes and reduce siltation. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, increases water infiltration and reduces erosion.

The use of the soil for pasture or hay effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poorer tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition. This soil is subject to frequent upslope runoff, but generally terraces and diversions can be used to control runoff.

This Judson soil is in capability subclass IIe.

8C—Judson silty clay loam, 5 to 9 percent slopes. This moderately sloping, well drained and moderately well drained soil is on foot slopes and convex alluvial fans. Typically, the slopes are short. Individual areas are long and narrow. Areas on foot slopes range from 3 to 8 acres, and areas on alluvial fans are 5 to 10 acres.

Typically, the surface layer is very dark grayish brown silty clay loam about 6 inches thick. The subsurface layer is silty clay loam about 20 inches thick. It is very dark grayish brown in the upper part and very dark brown in the lower part. The subsoil is silty clay loam about 34 inches thick. It is dark brown in the upper and middle parts and brown in the lower part.

Included with this soil in mapping are small areas of Colo soils. The Colo soils are poorly drained and are adjacent to waterways that dissect the Judson map unit. These soils make up 5 percent of the map unit. In places, small gullies dissect this map unit.

Permeability of this Judson soil is moderate, and surface runoff is medium. The available water capacity is very high. The content of organic matter in the surface layer is 3 to 4 percent. Typically, the surface layer is slightly acid or neutral. The subsoil is slightly acid or medium acid. The available potassium and available phosphorus in the subsoil are low. This soil has fair tilth.

Most areas of this soil are used as cropland, but some areas are in pasture. This soil is well suited to cultivated crops, hay, pasture, and trees. However, in many places this soil is associated with areas that are subject to erosion, gullying, and the accumulation of sediment. This soil is well suited to septic tank absorption fields and moderately suited to building site development.

This soil is moderately well suited to corn and soybeans and well suited to small grain and grasses and legumes for hay and pasture. Individual areas are generally small, and they are cropped with adjacent soils in most places. Most areas of this soil are subject to runoff from side slopes. This causes siltation and erosion, and in places runoff water concentrates and causes gullying. Diversion terraces help to reduce runoff and siltation by diverting the runoff from adjacent upland side slopes. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, increases water infiltration and reduces erosion.

The use of this soil for pasture or hay effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poorer tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition. Diversions help to protect the soil from overflow and siltation.

This Judson soil is in capability subclass IIIe.

11B—Colo-Ely complex, 2 to 5 percent slopes. This map unit consists of gently sloping, poorly drained and somewhat poorly drained soils on foot slopes, alluvial fans, and narrow flood plains. Most areas are along small streams on uplands. Individual areas of this complex are long and very narrow and range from 5 to more than 100 acres.

Mapped areas contain about 40 to 60 percent Colo soil and about 35 to 50 percent Ely soil. The poorly drained Colo soil is near stream channels. It is subject to frequent flooding. The Ely soil borders the Colo soil in most places and is not subject to flooding. The individual soil areas are so small that it is not practical to separate them in mapping.

Typically, the Colo soil has a surface layer of black silty clay loam about 10 inches thick. The subsurface layer is black silty clay loam about 27 inches thick. The next layer is very dark gray silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is light brownish gray silty clay loam. In places, the combined thickness of the surface layer and subsurface layer is less than 36 inches. In places, there are deposits of light colored, silt loam overwash 6 to 18 inches thick.

Typically, the Ely soil has a surface layer of black silty clay loam about 9 inches thick. The subsurface layer is silty clay loam about 17 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil is friable silty clay loam about 34 inches thick. It is dark grayish brown in the upper part and mottled, grayish brown and light brownish gray in the lower part. In places, there are deposits of light colored, silt loam overwash 6 to 18 inches thick.

Included in this complex are small areas of well drained and moderately well drained Judson soils. The Judson soils are on foot slopes and are not subject to flooding. Judson soils make up 5 to 15 percent of the complex.

Permeability of the Colo soil and Ely soil is moderate. Surface runoff is slow for the Colo soil and medium for the Ely soil. The available water capacity is high for the Colo soil and very high for the Ely soil. Both soils have a seasonal high water table. The content of organic matter in the surface layer is about 5 to 7 percent in the Colo soil and 5 to 6 percent in the Ely soil. Typically, both soils are neutral to medium acid. The available phosphorus is medium in the substratum for the Colo soil and very low in the subsoil for the Ely soil. The substratum of the Colo soil and the subsoil of the Ely soil are very low in available potassium. Both soils have fair tilth.

Most areas of this complex are cultivated, but some areas are in pasture or grassed waterways. These soils are well suited to cultivated crops, hay, and pasture. They are poorly suited to sanitary facilities and building site development.

These soils are well suited to corn, soybeans, small grains, and grasses and legumes for hay and pasture. Individual areas that are small in size are cropped with adjacent soils in most places. Maintaining grassed waterways in this complex is an effective method of controlling erosion and gullying (fig. 9). Some areas receive runoff from side slopes, which causes siltation. Other areas are subject to short duration flooding from small streams. Diversions and channel improvements can provide flood protection and divert runoff from adjacent side slopes. Artificial drainage helps to improve timeliness of tillage operations and maintain tilth.

The use of these soils for pasture or hay effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poorer tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

The soils in this complex are in capability subclass IIw.

20C2—Killduff silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained and moderately well drained soil is on convex side slopes and upper coves of drainageways. Individual areas are irregular in shape and range from 5 to 20 acres.

Typically, the surface layer is mixed, very dark grayish brown and brown silty clay loam about 7 inches thick. The subsoil is friable silty clay loam about 31 inches thick. It is brown in the upper part, grayish brown in the middle part, and grayish brown and light brownish gray in the lower part. The substratum to a depth of about 60 inches is light brownish gray silt loam. Some areas have a dark brown, silt loam surface layer about 9 inches thick.

Included with this soil in mapping are small areas of Clarinda soils at the heads of the drains. Clarinda soils are poorly drained. They make up 5 percent of the map unit.

Permeability of this Killduff soil is moderate, and surface runoff is medium. The available water capacity is high. The surface layer is neutral. The subsoil is slightly acid or neutral. The subsoil is medium to low in available phosphorus and very low in available potassium. The content of organic matter is about 2 to 2.5 percent in the surface layer. This soil has fair tilth.

Areas of this soil are mostly cultivated and used intensively for row crops. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is moderately suited to sanitary facilities and building site development.

This soil is well suited to corn and soybeans if they are used in rotation with oats and hay. The soil needs to be tilled on the contour, stripcropped, or terraced to help control erosion. If terraced, this soil can be used for row crops at least half of the time without serious soil loss. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, increases water

Figure 9.—Grassed waterways prevent the formation of gullies in the Colo-Ely complex.

infiltration and reduces erosion. All crop residue should be returned to maintain tilth.

This Killduff soil is in capability subclass IIIe.

20D2—Killduff silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained and moderately well drained soil is on convex side slopes and head slopes of drainageways. Individual areas are irregular in shape and range from 5 to 25 acres.

Typically, the surface layer is mixed very dark grayish brown and brown silty clay loam about 7 inches thick. The subsoil is friable silty clay loam about 30 inches thick. It is brown in the upper part and brown and grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled silt loam. In places, the surface layer is brown silty clay loam.

Included with this soil in mapping are small areas of Clarinda soils at the heads of drains. These soils are poorly drained and make up about 5 percent of the map unit.

Permeability of the Killduff soil is moderate, and surface runoff is rapid. The content of organic matter is about 1 to 1.5 percent in the surface layer. The available water capacity is high. The surface layer is neutral and the subsoil is slightly acid or neutral. The subsoil is medium to low in available phosphorus and very low in available potassium. This soil has fair tilth.

Areas of this soil are cultivated and used somewhat intensively for row crops. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is moderately suited to septic tank filter fields and building site development.

This soil is moderately suited to corn and soybeans if oats and hay are used at least half of the time in the rotation system. The soil needs conservation tillage, a practice that leaves crop residue on the surface throughout the year, along with contouring, stripcropping, or terracing to help control erosion in cultivated fields. Row crops can be included in the rotation more often if the soil is terraced and tilled on the contour. Grassed waterways are needed to prevent the formation of gullies. In many places, terrace drop inlets can be constructed. Conservation tillage increases water infiltration and reduces the hazard of erosion.

This Killduff soil is in capability subclass IIIe.

20D3—Killduff silty clay loam, 9 to 14 percent slopes, severely eroded. This strongly sloping, well drained and moderately well drained soil is on convex side slopes and, typically, on head slopes of drainageways. Individual areas are irregular in shape and range from 5 to 25 acres.

Typically, the surface layer is brown silty clay loam that has some mixing of very dark grayish brown and is about 7 inches thick. The subsoil is friable silty clay loam about 29 inches thick. It is brown with a few grayish brown mottles in the upper part and grayish brown and light brownish gray in the lower part. The substratum to a depth of about 60 inches is mottled, light brownish gray silt loam that has a few dark mineral accumulations.

Permeability of this Killduff soil is moderate, and surface runoff is rapid. The available water capacity is high. The content of organic matter is less than 1 percent in the surface layer. The surface layer is slightly acid, unless it has been limed in the past few years. The subsoil is medium acid or slightly acid. The subsoil is medium to low in available phosphorus and very low in available potassium. This soil has fair tilth.

Areas of this soil are mostly cultivated and are mainly used for row crops. This soil is poorly suited to cultivated crops but is well suited to hay and pasture. It is moderately suited to septic tank filter fields and building site development.

This soil is best suited to hay and pasture. It is poorly suited to corn and soybeans but can be planted to row crops occasionally if erosion is controlled. Because much of the original surface layer and its content of organic matter has been lost through erosion, maintaining good tilth is difficult. Terraces can be used on this soil, but they are not well suited. Slopes are steeper than desirable, and the low content of organic matter restricts plant growth, especially in the terrace channels. Contour tillage, stripcropping, and tillage methods that leave mulch on the surface are alternatives to terraces. Good use of crop residue and manure helps to improve tilth.

This Killduff soil is in capability subclass IVe.

20E2—Killduff silty clay loam, 14 to 18 percent slopes, moderately eroded. This moderately steep, well drained to moderately well drained soil is on convex side slopes near the head slopes of drainageways. Individual areas are irregular in shape and range from 5 to 25 acres.

Typically, the surface layer is mixed very dark grayish brown and brown silty clay loam about 5 inches thick. The subsoil is friable silty clay loam about 30 inches thick. It is brown in the upper part and mottled, brown and grayish brown in the lower part. The substratum to a depth of about 60 inches is mottled, grayish brown, friable silt loam.

Included with this soil are small, severely eroded areas where the surface layer consists mainly of mixed, brown silty clay loam. Also included are small areas of Clarinda soils at the heads of drains. These soils are poorly drained and make up 5 percent of the map unit.

Permeability of this Killduff soil is moderate, and surface runoff is rapid. The available water capacity is high. The content of organic matter is about 1 to 1.5 percent in the surface layer. The surface layer is slightly acid, unless the soil has been limed in the past few years. The subsoil is medium acid or slightly acid. The subsoil is medium to low in available phosphorus and very low in available potassium. This soil has fair tilth.

Areas of this soil are mostly cultivated. This soil is poorly suited to cultivated crops but is well suited to hay and pasture. It is poorly suited to sanitary facilities and building site development.

This soil is best suited to hay and pasture. It is poorly suited to corn and soybeans, but row crops can be used with hay and pasture. The use of this soil for oats, hay, and pasture effectively helps to control erosion. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, and stripcropping with half the area in meadow help to control erosion. Conservation tillage and tilling on the contour reduces runoff and increases water infiltration. Return of all crop residue helps to maintain tilth and fertility. Terraces are not well suited to this soil. Slopes are steeper than desirable, and the low content of organic matter restricts plant growth, especially in the terrace channels. In places, grassed waterways need to be tiled or reshaped and seeded to permanent vegetation.

This Killduff soil is in capability subclass IVe.

20E3—Killduff silty clay loam, 14 to 18 percent slopes, severely eroded. This moderately steep, well drained and moderately well drained soil is on convex side slopes near the head slopes of drainageways. Individual areas are irregular in shape and range from 5 to 25 acres.

Typically, the surface layer is brown mixed with some dark brown silty clay loam about 7 inches thick. The subsoil is friable silty clay loam about 29 inches thick. The upper part is dark yellowish brown with a few grayish brown mottles, and the lower part is mottled brown and grayish brown. The substratum to a depth of about 60 inches is mottled, light brownish gray silt loam.

Permeability of this soil is moderate, and surface runoff is rapid. The available water capacity is high. The content of organic matter is less than 0.5 percent in the surface layer. The surface layer is slightly acid, unless the soil has been limed in the past few years. The subsoil is medium acid or slightly acid. The subsoil is medium to low in available phosphorus and very low in available potassium. This soil has fair tilth.

Areas of this soil are mostly cultivated. This soil is generally unsuitable for cultivated crops but is moderately suited to hay and pasture. It is poorly suited to sanitary facilities and building site development.

This soil is best suited to hay and pasture. It is generally unsuitable for corn and soybeans. The use of

this soil for hay and pasture effectively helps to control erosion. Terraces are not well suited to this soil. Slopes are steeper than desirable, and the low content of organic matter restricts plant growth, especially in the terrace channels. In places, grassed waterways need to be tiled or reshaped and seeded to permanent vegetation.

This Killduff soil is in capability subclass VIe.

24D2—Shelby loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained and moderately well drained soil is on convex side slopes and narrow, convex nose slopes. Individual areas are 5 to 45 acres. They are irregular in shape and occur as narrow bands that commonly border drainageways.

Typically, the surface layer is mixed very dark grayish brown, brown, and dark brown loam about 7 inches thick. The subsoil is firm clay loam about 38 inches thick. It is dark yellowish brown in the upper part and yellowish brown and mottled in the lower part. The substratum to a depth of about 60 inches is grayish brown and yellowish brown, mottled clay loam. In places, bands or pockets of loam or fine sandy loam are in the lower part of the subsoil. In places, the surface layer is very dark brown loam about 10 inches thick.

Included with this soil in mapping are small areas of Adair soils and bands of gray or grayish brown clay. These two inclusions are high on the side slope and during extended wet periods have a perched water table that causes seeps. These soils make up 5 to 10 percent of the map unit.

Permeability of this Shelby soil is moderately slow, and surface runoff is rapid. The available water capacity is high. The content of organic matter in the surface layer is 1 to 2 percent. The surface layer is medium acid, unless the soil has been limed in the past few years, and the subsoil is medium acid. The subsoil is low in available phosphorus and very high in available potassium. This soil has fair tilth.

Areas of this soil are used for row crops, hay, and pasture. This soil is moderately suited to cultivated crops, hay, and pasture. It is poorly suited to sanitary facilities and moderately suited to building site development.

This soil is moderately suited to grasses, legumes, corn, and soybeans. If the soil is used for cultivated crops, soil erosion is a hazard. To control erosion, this soil needs to be tilled on the contour, stripcropped, or terraced. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, tilling on the contour, and terracing increase water infiltration and help control runoff of excess water. Grassed waterways are needed to prevent the formation of gullies. In many places, terrace drop inlets can be constructed. The return of all crop residue helps to maintain tilth.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when this soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotations, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Shelby soil is in capability subclass IIIe.

24D3—Shelby clay loam, 9 to 14 percent slopes, severely eroded. This strongly sloping, well drained and moderately well drained soil is on convex side slopes and narrow, convex nose slopes. Individual areas are 5 to 15 acres. They are irregular or finely lobed in shape and occur as narrow bands that commonly border drainageways.

Typically, the surface layer is brown mixed with very dark grayish brown clay loam about 7 inches thick. The subsoil is firm clay loam about 35 inches thick. It is dark yellowish brown in the upper part and yellowish brown and mottled in the lower part. The substratum to a depth of about 60 inches is grayish brown and yellowish brown, mottled clay loam. In places, bands or pockets of loam or fine sandy loam are in the lower part of the subsoil.

Included with this soil in mapping are small areas of Adair soils and bands of gray or grayish brown clay. These two inclusions are high on the side slope and during extended wet periods have a perched water table that causes seeps. They make up about 5 percent of the map unit.

Permeability of this Shelby soil is moderately slow, and surface runoff is rapid. The available water capacity is high. The content of organic matter in the surface layer is less than 1 percent. The surface layer is medium acid, unless the soil has been limed in the past few years, and the subsoil is medium acid. The subsoil is low in available phosphorus and very low in available potassium. This soil has poor tilth.

Areas of this soil are used for row crops, hay, and pasture. This soil is poorly suited to cultivated crops and moderately suited to hay and pasture. It is poorly suited to sanitary facilities and moderately suited to building site development.

This soil is poorly suited to corn and soybeans. If the soil is cultivated, soil erosion is a hazard. To control erosion, this soil needs to be tilled on the contour, stripcropped, or terraced. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, and terraces increase water infiltration and help control runoff. Grassed waterways are needed to prevent the formation of gullies. In many places, terrace drop inlets can be constructed. The return of all crop residue helps to improve tilth.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when this soil is wet causes surface compaction, increases runoff, and results in continued poor tilth. Proper stocking rates, pasture rotations, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This Shelby soil is in capability subclass IVe.

24E2—Shelby loam, 14 to 18 percent slopes, moderately eroded. This moderately steep, well drained and moderately well drained soil is on convex side slopes. Individual areas are 5 to 40 acres. They are irregular in shape and occur as narrow bands that commonly border drainageways.

Typically, the surface layer is mixed very dark grayish brown, brown, and dark brown loam about 7 inches thick. The subsoil is firm clay loam about 38 inches thick. It is dark yellowish brown in the upper part, yellowish brown in the middle part, and yellowish brown and mottled in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled clay loam. In places, the surface layer is very dark brown loam about 10 inches thick.

Included with this soil in mapping are small areas of Adair soils and bands of gray or grayish brown clay. These two inclusions are high on the side slope and during extended wet periods have a perched water table that causes seeps. They make up 5 to 10 percent of the map unit.

Permeability of this Shelby soil is moderately slow, and surface runoff is rapid. The available water capacity is high. The content of organic matter in the surface layer is 0.5 to 1.5 percent. The surface layer is medium acid, unless the soil has been limed in the past few years. The subsoil is medium acid, low in available phosphorus, and very low in available potassium. This soil has fair tilth.

Areas of this soil are used for corn, hay, and pasture. This soil is poorly suited to cultivated crops and moderately suited to hay and pasture. It is poorly suited to sanitary facilities and building site development.

This soil is better suited to grasses and legumes than to other crops. It is poorly suited to corn and soybeans. If the soil is used for cultivated crops, soil erosion is a hazard. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, and stripcropping with half the area in meadow help to control erosion. Conservation tillage and tilling on the contour increase water infiltration and help to control runoff. Grassed waterways are needed to prevent the formation of gullies. Slopes are too steep for terracing. The return of crop residue helps to maintain tilth.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when this soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotations, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Shelby soil is in capability subclass IVe.

24E3—Shelby clay loam, 14 to 18 percent slopes, severely eroded. This moderately steep, well drained and moderately well drained soil is on convex side slopes. Individual areas are 5 to 20 acres. They are irregular in shape and occur as narrow bands that commonly border drainageways.

Typically, the surface layer is brown with mixed very dark grayish brown clay loam about 7 inches thick. The subsoil is firm clay loam about 30 inches thick. It is dark yellowish brown and yellowish brown in the upper part and yellowish brown and mottled in the lower part. The substratum to a depth of about 60 inches is light brownish gray and yellowish brown, mottled clay loam. In places, a few stones and cobbles are in the surface layer.

Included with this soil in mapping are small areas of Adair soils and bands of gray or grayish brown clay. These two inclusions are high on the side slopes and during extended wet periods have a perched water table that causes seeps. They make up 5 percent of the map unit.

Permeability of this Shelby soil is moderately slow, and surface runoff is rapid. The available water capacity is high. The content of organic matter in the surface layer is less than 1 percent. The surface layer is medium acid, unless the soil has been limed in the past few years. The subsoil is medium acid, low in available phosphorus, and very low in available potassium. This soil has poor tilth.

Areas of this soil are used for cultivated crops, hay, and pasture. This soil is generally unsuitable for cultivated crops but is moderately suited to hay and pasture. It is poorly suited to sanitary facilities and building site development.

This soil is best suited to hay and pasture. It is generally unsuitable for corn and soybeans. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, and tilling on the contour reduce runoff and increase water infiltration. Return of all crop residue helps to maintain tilth and fertility. Terraces are not well suited to these soils. Slopes are steeper than desirable, and the low organic matter content restricts plant growth, especially in the terrace channels. In places, grassed waterways need to be tiled or reshaped and seeded to permanent vegetation.

The use of this soil for pasture, oats, or hay also effectively helps to control erosion. Overgrazing or grazing when this soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotations, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Shelby soil is in capability subclass VIe.

24F2—Shelby loam, 18 to 25 percent slopes, moderately eroded. This steep, well drained and moderately well drained soil is on convex side slopes and narrow convex nose slopes. Individual areas are 10 to 15 acres. They are irregular in shape and occur as narrow bands that commonly border drainageways.

Typically, the surface layer is mixed very dark grayish brown, brown, and dark brown loam about 7 inches thick. The subsoil is firm clay loam about 35 inches thick. It is dark yellowish brown in the upper part and yellowish

brown and mottled in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled clay loam. In places, the surface layer is very dark brown loam about 10 inches thick.

Included with this soil in mapping are small areas of Adair soils high on the side slopes and nose slopes. During extended wet periods these soils have a perched water table that causes seeps. These soils make up about 10 percent of the map unit.

Permeability of this Shelby soil is moderately slow, and surface runoff is very rapid. The available water capacity is high. The content of organic matter in the surface layer is 0.5 to 1.5 percent. The surface layer is medium acid, unless the soil has been limed in the past few years. The subsoil is medium acid, low in available phosphorus, and very low in available potassium.

Areas of this soil are used for pasture, hay, and cultivated crops. This soil is generally unsuitable for pasture. It is generally unsuitable for sanitary facilities and building site development.

This soil is best suited to trefoil or bluegrass pasture and to trees. It is generally unsuitable for all cultivated crops, hay, and bromegrass. This soil is susceptible to severe sheet and gully erosion. The operation of farm machinery is difficult because of the steep slopes and the presence of gullies. Slopes are too steep for terracing. The use of this soil for pasture effectively helps to control erosion. Control of grazing is necessary to prevent serious damage to vegetation.

This Shelby soil is in capability subclass VIe.

41B—Sparta loamy fine sand, 2 to 5 percent slopes. This gently sloping, excessively drained soil is on convex upland summits, crests of escarpments, and convex dunes on stream benches. Individual areas are elliptical or coarsely lobed and range from 3 to 20 acres.

Typically, the surface layer is very dark brown loamy fine sand about 7 inches thick. The subsurface layer is very dark grayish brown loamy fine sand about 12 inches thick. The subsoil is dark yellowish brown, very friable loamy fine sand about 13 inches thick. The substratum to a depth of about 60 inches is yellowish brown sand. In places, the combined thickness of the surface layer and subsurface layer is less than 10 inches.

Included with this soil in mapping are small areas of somewhat excessively drained Dickinson and well drained Tama soils. Also included are some small areas of somewhat poorly drained soils that have a surface soil more than 36 inches thick. The Dickinson and Tama soils are finer textured and are higher in available water capacity. The included soils make up about 10 percent of the map unit.

Permeability of this Sparta soil is rapid, and surface runoff is slow. The available water capacity is low. The content of organic matter in the surface layer is 1 to 2 percent. The surface layer is neutral to medium acid. The subsoil is medium acid or strongly acid and is very low in available phosphorus and available potassium. Tilth is good.

Areas of this soil are used for hay, pasture, woodland, and cultivated crops. This soil is poorly suited to cultivated crops, hay, and pasture. It is moderately suited to trees. This soil is poorly suited to sanitary facilities but is well suited to building site development.

This soil is poorly suited to corn and soybeans. It has low available water capacity and is droughty. This soil has low natural fertility, and it is difficult to vegetate. Erosion by wind is a major hazard. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, and stripcropping are needed to reduce soil loss. A good cover crop and grassed waterways help to prevent the formation of gullies.

This soil is moderately suited to trees, but most areas of trees are limited to groves around farmsteads. Natural and planted seedlings do not survive well, but seedlings can be spaced closer together. The surviving trees can be thinned later to achieve the desired stand density. Competing vegetation needs to be controlled by site preparation or by spraying or cutting. There are no other hazards for planting or harvesting trees.

This Sparta soil is in capability subclass IVs.

41C—Sparta loamy fine sand, 5 to 9 percent slopes. This moderately sloping, excessively drained soil is on convex upland summits, side slopes, and crests of escarpments. Individual areas are slightly elongated and range from 3 to 20 acres.

Typically, the surface layer is very dark brown loamy fine sand about 7 inches thick. The subsurface layer is very dark grayish brown loamy fine sand about 12 inches thick. The subsoil is dark yellowish brown, very friable loamy fine sand about 14 inches thick. The substratum to a depth of about 60 inches is yellowish brown sand. In places, the combined thickness of the surface layer and subsurface layer is less than 10 inches.

Included with this soil in mapping are small areas of somewhat excessively drained Dickinson soils. Dickinson soils are finer textured and are higher in available water capacity. They make up 5 to 10 percent of the unit.

Permeability of this Sparta soil is rapid, and surface runoff is slow. The available water capacity is low. The content of organic matter is about 0.5 to 1 percent in the surface layer. The surface layer is neutral to medium acid, and the subsoil is medium acid or strongly acid. The subsoil is very low in available phosphorus and available potassium. Tilth is good.

Areas of this soil are used for hay, pasture, woodland, and cultivated crops. This soil is generally unsuitable for cultivated crops and poorly suited to hay and pasture. It is moderately suited to trees. This soil is poorly suited to sanitary facilities and moderately suited to building site development.

This soil is generally unsuitable for corn and soybeans. It has low available water capacity and is droughty. This soil has low natural fertility, and it is difficult to vegetate. Erosion by wind is a major hazard. A good cover crop and grassed waterways help to prevent the formation of gullies.

This soil is moderately suited to trees, but most areas of trees are limited to groves around farmsteads. Natural and planted seedlings do not survive well, but seedlings can be spaced closer together. The surviving trees can be thinned later to achieve the desired stand density. Competing vegetation needs to be controlled by site preparation or by spraying or cutting. There are no other hazards for planting or harvesting trees.

This Sparta soil is in capability subclass VIs.

41D—Sparta loamy fine sand, 9 to 14 percent slopes. This strongly sloping, excessively drained soil is on convex side slopes. Individual areas are narrow and range from 5 to 15 acres.

Typically, the surface layer is very dark grayish brown loamy fine sand about 7 inches thick. The subsurface layer is very friable, dark grayish brown loamy fine sand about 8 inches thick. The subsoil is dark yellowish brown, very friable loamy fine sand about 14 inches thick. The substratum to a depth of about 60 inches is yellowish brown sand. In places, the combined thickness of the surface layer and subsurface layer is less than 10 inches.

Included with this soil in mapping are small areas of somewhat excessively drained Dickinson soils. They are higher in available water capacity and make up 5 to 10 percent of this map unit.

Permeability of this Sparta soil is rapid, and surface runoff is medium. The available water capacity is low. The content of organic matter is about 0.5 to 1 percent in the surface layer. The surface layer is neutral to medium acid, and the subsoil is medium acid or strongly acid. The subsoil is very low in available phosphorus and available potassium. Tilth is good.

Areas of this soil are used for hay, pasture, woodland, and cultivated crops. This soil is generally unsuitable for cultivated crops and poorly suited to hay and pasture. It is moderately suited to trees. This soil is poorly suited to sanitary facilities and moderately suited to building site development.

This soil is generally unsuitable for corn, soybeans, and oats. It has low available water capacity and is droughty. This soil has low natural fertility, and it is difficult to vegetate. Erosion by wind is a major hazard. A good cover crop and grassed waterways help to prevent the formation of gullies.

This soil is moderately suited to trees, but most areas of trees are limited to groves around farmsteads. Natural and planted seedlings do not survive well, but seedlings can be spaced closer together. The surviving trees can be thinned later to achieve the desired stand density. Competing vegetation needs to be controlled by site preparation or by spraying or cutting. There are no other hazards for planting or harvesting trees.

This Sparta soil is in capability subclass VIs.

43—Bremer silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on low stream benches or high second bottoms along major streams. Areas of this soil are subject to rare flooding. Individual areas are generally broad, but some are linear. Areas range from 10 to 100 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black silty clay loam about 7 inches thick. The subsoil is firm silty clay loam about 34 inches thick. It is black and very dark gray in the upper part and dark grayish brown and gray in the lower part. The substratum to a depth of about 60 inches is gray silty clay loam.

Included with this soil in mapping are soils in small concave depressions. These areas are higher in clay and become ponded. They make up 5 percent of this map unit.

Permeability of this Bremer soil is moderately slow, and surface runoff is slow. This soil has a seasonal high water table. The available water capacity is high. The content of organic matter is about 5 to 7 percent in the surface layer. The surface layer is slightly acid, unless the soil has been limed in the past few years. Typically, the subsoil is medium acid or slightly acid. The substratum is generally low in available phosphorus and available potassium. Typically, the surface layer has fair tilth.

Most areas of this soil are cultivated. This soil is well suited to cultivated crops, hay, and pasture if adequately drained. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn and soybeans if it is adequately drained. In some areas, surface drains are needed to remove surface water.

This Bremer soil is in capability subclass IIw.

51—Vesser silt loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained and poorly drained soil is on high bottom lands, foot slopes, and alluvial fans. Areas of this soil are subject to occasional flooding. Typical areas are elliptical and range from 4 to 15 acres.

Typically, the surface layer is black silt loam about 11 inches thick. The subsurface layer is very dark grayish brown, dark gray, and dark grayish brown silt loam about 17 inches thick. The subsoil is very dark gray, firm silty clay loam to a depth of 55 inches. The substratum to a depth of about 60 inches is dark gray silty clay loam. Some areas have dark brown silt loam overwash up to 18 inches thick.

Included with this soil in mapping are small areas of Bremer soils. Bremer soils do not have a silt loam surface layer and subsurface layer and are poorly drained. They make up 5 percent of this map unit.

Permeability of this Vesser soil is moderate, and surface runoff is slow. The available water capacity is high. This soil has a seasonal high water table. The content of organic matter in the surface layer is 3 to 4 percent. The surface layer is slightly acid to medium acid, unless the soil has been limed in the past few years. The subsoil is medium acid, medium in available

phosphorus, and low in available potassium. This soil has good tilth.

Most areas of this soil are in cropland. This soil is well suited to cultivated crops, hay, and pasture if protected from run-on water and if tile outlets are available. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn and soybeans if drainage is adequate. Open drains and tile outlets are necessary to adequately drain this soil. This soil generally occurs as small areas within larger areas of better drained soils. Areas of this soil are subject to flooding because of runoff from adjoining soils. Return of all crop residue helps to maintain tilth.

This Vesser soil is in capability subclass IIw.

54—Zook silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on flood plains. Areas of this soil are subject to occasional flooding. Typical areas are broad and irregular in shape and range from 5 to more than 100 acres.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is black silty clay loam and silty clay about 31 inches thick. The subsoil is very dark gray and grayish brown, friable silty clay loam to a depth of about 60 inches. Some areas have about 12 inches of silt loam overwash.

Included with this soil in mapping are small depressional areas that are high in organic matter content. These areas contain marsh vegetation. Marsh areas pond water for long periods and are not cultivated. These areas make up 5 percent of this map unit.

Permeability of this Zook soil is slow, and surface runoff is slow to very slow. The available water capacity is high. This soil has a seasonal high water table. The content of organic matter in the surface layer is 5 to 7 percent. The surface layer is slightly acid or neutral, and the subsoil is medium acid to mildly alkaline, low in available phosphorus, and very low in available potassium. This soil has poor tilth.

Most areas of this soil are in cropland. This soil is well suited to cultivated crops if adequately drained and if protected from flooding. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn and soybeans if drainage is adequate. Areas can be drained by tile and surface drains if adequate outlets are available. Diversions, levees, and channel improvements are used to control flooding and runoff from adjacent areas. Artificial drainage improves the timeliness of field operations and helps to improve tilth.

This Zook soil is in capability subclass IIw.

55—Nicollet loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is on slightly convex or plane, sloping ground moraines that have low relief. In places, this soil is on toe slopes or in the upper part of drainageways. Individual areas are irregular in shape and range from 5 to 40 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is loam about 12 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is friable clay loam about 13 inches thick. It is dark grayish brown with dark yellowish brown mottles in the upper and middle parts and dark grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled loam.

Included with this soil in mapping are a few small areas of Webster and Okoboji soils that are poorly drained or very poorly drained. These soils are on lower areas and have a heavier textured subsoil. The Okoboji soils pond water. These soils make up 5 to 10 percent of this map unit.

Permeability of this Nicollet soil is moderate, and surface runoff is slow. This soil has a seasonal high water table. The available water capacity is high. The surface layer is slightly acid or neutral, and the subsoil is slightly acid or medium acid. The content of organic matter is about 5 to 6 percent in the surface layer. The subsoil is very low in available phosphorus and very low to low in available potassium. This soil has good tilth.

Most areas of this soil are cultivated. This soil is well suited to cultivated crops, hay, and pasture. It is poorly suited to sanitary facilities and moderately suited to building site development.

This soil is well suited to corn and soybeans. If the soil is used for cultivated crops, there is a very slight hazard of erosion on the more sloping areas. Adequate drainage for the fluctuating water table may be beneficial. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, helps to prevent soil loss caused by wind erosion. Returning crop residue helps to maintain good tilth.

If used for pasture or hay, overgrazing or grazing when the soil is wet causes surface compaction and decreased infiltration. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Nicollet soil is in capability class I.

62D2—Storden loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex side slopes of the uplands. Typically, the slopes are short. Individual areas are long and narrow and range from 10 to 20 acres.

Typically, the surface layer is light yellowish brown and dark grayish brown, calcareous loam. The substratum to a depth of about 60 inches is calcareous loam. The upper part is light yellowish brown, the middle part is pale brown, and the lower part is light brownish gray.

Included with this soil in mapping are a few small areas that contain more sand and gravel and are droughty. They make up 5 to 10 percent of the map unit.

Permeability of this Storden soil is moderate, and surface runoff is rapid. The available water capacity is

high. The surface layer is mildly alkaline or moderately alkaline. The content of organic matter is about 0.5 to 1.5 percent in the surface layer. The subsoil is very low in available phosphorus and available potassium. This soil has good tilth.

Most areas of this soil are cultivated. This soil is moderately suited to cultivated crops, hay, and pasture. It is moderately suited to septic tank filter fields and building site development.

This soil is moderately suited to corn and soybeans. In places, gullying is a hazard. Soil loss can be reduced significantly by using a combination of such conservation practices as conservation tillage, a practice that leaves crop residue on the surface throughout the year; contour farming; terraces; crop rotation; or stripcropping. Short, irregular slopes make providing adequate erosion control difficult in many places. Returning crop residue or regularly adding other forms of organic matter helps to improve fertility and tilth and increases water infiltration.

If used for pasture or hay, overgrazing or grazing when the soil is wet causes surface compaction and increased runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Storden soil is in capability subclass IIIe.

63C—Chelsea loamy fine sand, 5 to 9 percent slopes. This moderately sloping, excessively drained soil is on convex upland summits, on side slopes, and on crests of escarpments. Individual areas are coarsely lobed and range from 2 to 100 acres.

Typically, the surface layer is very dark gray and very dark grayish brown loamy fine sand about 5 inches thick. The subsurface layer, about 33 inches thick, is brown loamy fine sand in the upper part and dark yellowish brown fine sand in the lower part. The underlying layer to a depth of about 60 inches is yellowish brown fine sand that has sandy loam bands.

Included in this soil in mapping are small areas of silty Fayette soils that have higher available water capacity and organic matter content. They make up 5 to 10 percent of this map unit.

Permeability of this Chelsea soil is rapid, and surface runoff is slow. The available water capacity is low. The content of organic matter is less than 0.5 percent in the surface layer. The surface layer and subsurface layer are medium acid or strongly acid, unless the soil has been limed in the past few years. The subsoil is very low in available phosphorus and available potassium. This soil has good tilth.

Areas of this soil are used for hay, pasture, woodland, and cultivated crops. This soil is poorly suited to cultivated crops, hay, and pasture. It is moderately suited to trees. This soil is poorly suited to sanitary facilities and moderately suited to building site development.

This soil is poorly suited to corn, soybeans, hay, or pasture. It has low available water capacity and is droughty. This soil has low natural fertility, and it is difficult to vegetate. Erosion by wind is a major hazard. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, and stripcropping are needed to reduce soil loss. A good cover crop and grassed waterways help to prevent the formation of gullies.

This soil is moderately suited to trees, but most areas of trees are limited to groves around farmsteads. Natural and planted seedlings do not survive well, but seedlings can be spaced closer together. The surviving trees can be thinned later to achieve the desired stand density. Competing vegetation needs to be controlled by site preparation or by spraying or cutting. There are no other hazards for planting or harvesting trees.

This Chelsea soil is in capability subclass IVs.

63E—Chelsea loamy fine sand, 9 to 18 percent slopes. This strongly sloping to moderately steep, excessively drained soil is on convex side slopes. Individual areas are narrow and range from 5 to 100 acres.

Typically, the surface layer is dark brown loamy fine sand about 4 inches thick. The subsurface layer, about 30 inches thick, is dark grayish brown loamy fine sand in the upper part and brown and yellowish brown fine sand in the lower part. The underlying layer to a depth of about 60 inches is yellowish brown fine sand that has sandy loam bands starting at a depth of 38 inches.

Included with this soil in mapping are small areas of silty Fayette soils that have higher available water capacity and organic matter content. They make up 5 to 10 percent of this map unit.

Permeability of this Chelsea soil is rapid, and surface runoff is medium. The available water capacity is low. The content of organic matter in the surface layer is less than 0.5 percent. The surface layer and subsurface layer are medium acid or strongly acid, unless the soil has been limed in the past few years. The subsurface layer is very low in available phosphorus and available potassium. This soil has good tilth.

Areas of this soil are used for hay, pasture, and woodland. This soil is generally unsuitable for cultivated crops and poorly suited to hay and pasture. It is moderately suited to trees. This soil is poorly suited to sanitary facilities and building site development.

This soil is generally unsuitable for corn or soybeans. It has low available water capacity and is droughty. This soil has low natural fertility, and it is difficult to vegetate. Erosion by wind is a major hazard. Farm machinery can be used to establish hay or renovate pastures. It is important to keep a good cover on this soil to help conserve moisture and control water erosion and wind erosion. Control of grazing is essential.

This soil is moderately suited to trees, but most areas of trees are limited to groves around farmsteads. Natural and planted seedlings do not survive well, but seedlings can be spaced closer together. The surviving trees can

be thinned later to achieve the desired stand density. Competing vegetation needs to be controlled by site preparation or by spraying or cutting. There are no other hazards for planting or harvesting trees.

This Chelsea soil is in capability subclass VIs.

65F—Lindley loam, 18 to 25 percent slopes. This steep, well drained soil is on convex, dissected side slopes of the uplands. Typical areas are moderately long, narrow bands on the lower part of the side slope and range from 10 to 150 acres.

Typically, the surface layer is very dark gray loam about 3 inches thick. The subsurface layer is dark grayish brown loam about 4 inches thick. The subsoil, about 43 inches thick, is brown and strong brown, friable loam in the upper part; strong brown, firm clay loam in the middle part; and yellowish brown, firm clay loam in the lower part. The substratum to a depth of about 60 inches is yellowish brown loam.

Included with this soil in mapping are small areas of red clay, sandstone and limestone outcrops, and small areas of sand. The areas of red clay and patches of sand are high on the side slope and cause seeps during extended wet periods. The limestone and sandstone outcrops are on the low part of the side slopes. Limestone outcrops are near the Iowa River. Sandstone areas outcrop along Timber Creek. These inclusions make up 10 to 15 percent of the map unit.

Permeability of this Lindley soil is moderately slow, and surface runoff is rapid. The available water capacity is high. The content of organic matter is about 0.5 to 1 percent in the surface layer. The surface layer and the subsoil are strongly acid. The subsoil is medium in available phosphorus and very low in available potassium.

Areas of this soil are used for pasture and woodland. This soil is generally unsuitable for cultivated crops and hay. It is poorly suited to pasture and moderately suited to trees. This soil is poorly suited to sanitary facilities and building site development.

This soil is best suited to trefoil or bluegrass and woodland. It is generally unsuitable for all cultivated crops, hay, and bromegrass. This soil is susceptible to severe sheet and gully erosion. Slopes are too steep for terracing. The use of this soil for pasture effectively helps to control erosion. Control of grazing is necessary to prevent serious damage to vegetation.

This soil is moderately suited to trees, and small areas remain in native hardwoods. Careful consideration needs to be given to the location of trails or roads used in logging on this soil in order to reduce the possibility of erosion. Laying out the trails or roads on the contour or nearly on the contour helps to reduce soil erosion. The slope of this soil is steep enough so that some hazard is involved in the operation of equipment. Special equipment can be used, and caution should be exercised in its operation. Survival of seedlings or competition from undesirable plants probably will not be a problem.

This Lindley soil is in capability subclass VIIe.

65G—Lindley loam, 25 to 40 percent slopes. This very steep, well drained soil is on convex, dissected side slopes along major streams. Typical areas are long, narrow bands on the lower part of the side slope and range from 10 to 200 acres.

Typically, the surface layer is very dark gray loam about 4 inches thick. The subsurface layer is dark grayish brown loam about 6 inches thick. The subsoil is brown and yellowish brown clay loam about 27 inches thick. The substratum to a depth of about 60 inches is yellowish brown, calcareous clay loam.

Included with this soil in mapping are small areas of sandstone and limestone outcrops and small patches of sand. The small patches of sand are high on the side slope and cause seeps during extended wet periods. The limestone and sandstone outcrops are on the low part of the side slope. These inclusions make up 10 to 15 percent of the map unit.

Permeability of this Lindley soil is moderately slow, and surface runoff is rapid. The available water capacity is high. The content of organic matter is less than 1 percent in the surface layer. The surface layer is slightly acid, and the subsoil is strongly acid, medium in available phosphorus, and very low in available potassium.

Areas of this soil are used for woodland. This soil is generally unsuitable for cultivated crops, hay, and pasture. It is moderately suited to trees. This soil is generally unsuitable for sanitary facilities and building site development.

This soil is better suited to woodland than other uses. It is generally unsuitable for all cultivated crops, hay, and bromegrass. This soil is susceptible to severe sheet and gully erosion.

This soil is moderately suited to trees, and small areas remain in native hardwoods. Careful consideration should be given to the location of trails or roads used in logging on this soil in order to reduce the possibility of erosion. Laying out the trails or roads on the contour or nearly on the contour helps to reduce soil erosion. The slope of this soil is steep enough so that some hazard is involved in the operation of equipment. Special equipment can be used, and caution needs to be exercised in its operation. Survival of seedlings or competition from undersirable plants generally is not a problem.

This Lindley soil is in capability subclass VIIe.

88—Nevin silty clay loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is on plane or convex slopes of low stream benches or high second bottoms. Areas of this soil are subject to rare flooding. Individual areas range from 4 to 50 acres in a broad, irregular pattern.

Typically, the surface layer is black silty clay loam about 6 inches thick. The subsurface layer is silty clay

loam about 18 inches thick. It is black in the upper part and very dark gray and very dark grayish brown in the lower part. The subsoil is mottled, friable silty clay loam about 23 inches thick. It is dark grayish brown in the upper part and grayish brown in the middle and lower parts. The substratum to a depth of about 60 inches is grayish brown silty clay loam. In places, the subsoil is brown and does not have mottles in the upper part. In places, the surface layer is loam or fine sandy loam.

Included with this soil in mapping are small areas of poorly drained Bremer soils and small depressions. Bremer soils are on lower and more level parts of the low benches and second bottoms. The depressions are very poorly drained and are subject to ponding. These inclusions make up 10 percent of this map unit.

Permeability of this Nevin soil is moderate, and surface runoff is slow. The available water capacity is very high. This soil has a seasonal high water table. The content of organic matter in the surface layer is 4 to 6 percent. The surface layer and the upper part of the subsoil are slightly acid, unless the soil has been limed in the past few years. The lower part of the subsoil is neutral. The subsoil is medium in available phosphorus and medium in available potassium. Tilth is fair.

Areas of this soil are cultivated and used intensively for row crops. This soil is well suited to cultivated crops, hay, and pasture. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn, soybeans, small grains, and grasses and legumes for hay and pasture. This soil is slightly higher than the adjacent first bottom lands and is subject to rare flooding. In places, areas adjacent to foot slopes receive runoff. Diversions help to prevent runoff from adjacent side slopes. Tile drainage is not normally needed but is beneficial in some areas.

This soil is well suited to hay and pasture. Hay is used more often than pasture, and alfalfa is the main plant. Both warm and cool season grasses need to be included in pasture rotation systems. Grasses and legumes increase water infiltration, protect the soil from wind erosion, and improve tilth. Overgrazing or grazing when the soil is wet causes compaction and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Nevin soil is in capability class I.

93D2—Shelby-Adair complex, 9 to 14 percent slopes, moderately eroded. This map unit consists of strongly sloping, well drained, moderately well drained, and somewhat poorly drained soils on convex side slopes and nose slopes. Individual areas are irregular in shape and border drainageways in most places. They are 5 to 20 acres.

Mapped areas are from 40 to 50 percent Shelby soil and about 40 percent Adair soil. The well drained and moderately well drained Shelby soil is at lower elevations and occurs near the drainageways. The moderately well drained and somewhat poorly drained Adair soil is narrow bands between Shelby soil and soils formed in loess at higher elevations. The individual soil areas are so small in size that it is not practical to separate them in mapping.

Typically, the Shelby soil has a surface layer of mixed very dark grayish brown, brown, and dark brown loam about 7 inches thick. The subsoil is firm clay loam about 35 inches thick. It is dark yellowish brown in the upper part and yellowish brown and mottled in the lower part. The substratum to a depth of about 60 inches is grayish brown and yellowish brown, mottled clay loam.

Typically, the Adair soil has a surface layer of mixed very dark gray and brown clay loam about 6 inches thick. The subsoil to a depth of about 60 inches is brown, firm clay loam in the upper part; reddish brown and yellowish red, mottled, very firm silty clay in the middle part; and yellowish brown, mottled, firm clay loam in the lower part.

Included in the complex are small areas of Ely, Killduff, and Tama soils and small areas where the surface layer is mainly yellowish brown clay loam. The somewhat poorly drained Ely soil is on foot slopes. The well drained and moderately well drained Killduff and Tama soils are at the higher elevations. These soils make up 5 to 20 percent of the complex.

Permeability of the Shelby soil is moderately slow, and permeability of the Adair soil is slow. Surface runoff is rapid in both soils. The available water capacity is high for the Shelby soil and moderate for the Adair soil. The Adair soil has a seasonal high water table, and both soils are seasonally seepy. The content of organic matter is about 1.5 to 2.5 percent in the surface layer of the Adair soil and 1 to 2 percent in the surface layer of the Shelby soil. For both soils, the surface layer is neutral to medium acid and the subsoil is slightly acid to strongly acid. The available phosphorus in the subsoil is low for the Shelby soil and very low for the Adair soil. The available potassium in the subsoil is high for the Shelby soil and very low or low for the Adair soil. Tilth is fair for the Shelby soil and fair or poor for the Adair soil.

Areas of this complex are used for cultivated crops, hay, and pasture. These soils are poorly suited to row crops and moderately suited to hay, pasture, and oats. These soils are poorly suited to sanitary facilities and building site development.

These soils are poorly suited to corn and soybeans. Erosion is a hazard for cultivated soils. Contour tillage, terracing, and stripcropping help to reduce soil erosion and soil loss. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, tilling on the contour, and terracing increase water infiltration and control runoff. Grassed waterways help to prevent the formation of gullies. Terrace drop inlets can be constructed in many places. Interceptor tiles help to control seeps. The return of all crop residue helps to maintain tilth and fertility.

The use of these soils for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when the soils are wet causes compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotations, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

The soils in this complex are in capability subclass IVe.

93E2—Shelby-Adair complex, 14 to 18 percent slopes, moderately eroded. This map unit consists of moderately steep, well drained, moderately well drained, and somewhat poorly drained soils on dissected side slopes and convex nose slopes. Individual areas are irregular in shape and border drainageways in most places. They are 5 to 15 acres.

Mapped areas contain about 55 percent Shelby soil and 30 percent Adair soil. The well drained and moderately well drained Shelby soil is at lower elevations and occurs near the drainageways. The moderately well drained and somewhat poorly drained Adair soil is narrow bands between Shelby soil and soils formed in loess at higher elevations. The individual soil areas are so intricately mixed, or so small in size, that it is not practical to separate them in mapping.

Typically, the Shelby soil has a surface layer of mixed very dark grayish brown, brown, and dark brown loam about 7 inches thick. The subsoil is firm clay loam about 35 inches thick. It is dark yellowish brown in the upper part and yellowish brown and mottled in the lower part. The substratum to a depth of about 60 inches is mottled grayish brown, brown, and yellowish brown clay loam.

Typically, the Adair soil has a surface layer of mixed very dark gray and brown clay loam about 6 inches thick. The subsoil to a depth of about 60 inches is brown, firm clay loam in the upper part; reddish brown and yellowish red, mottled, very firm silty clay in the middle part; and yellowish brown, mottled, firm clay loam in the lower part.

Included in the complex are small areas of Ely, Killduff, and Tama soils and small areas where the surface layer is mainly brown clay loam or yellowish red clay. The somewhat poorly drained Ely soil is on foot slopes. The well drained and moderately well drained Killduff and Tama soils are at the higher elevations of the unit. These soils make up about 10 percent of the complex.

Permeability of the Shelby soil is moderately slow, and permeability of the Adair soil is slow. Surface runoff is rapid for Shelby soil and very rapid for Adair soil. The available water capacity is high for the Shelby soil and moderate for the Adair soil. The Adair soil has a seasonal high water table, and both soils are seasonally seepy. The content of organic matter is about 0.5 to 1.5 percent in the surface layer of the Adair soil and 0.5 to 1.5 percent in the Shelby soil. For both soils, the surface layer is neutral to medium acid and the subsoil is slightly acid to strongly acid. The available phosphorus in the subsoil is low for the Shelby soil and very low for the Adair soil. The available potassium in the subsoil is high for the Shelby soil and very low to low for the Adair soil. Tilth is fair for the Shelby soil and poor for the Adair soil.

Areas of this complex are used for row crops, hay, and pasture. These soils are generally unsuitable for row crops and hay and poorly suited to pasture. These soils are poorly suited to sanitary facilities and building site development.

These soils are generally unsuitable for corn, soybeans, and oats. Erosion is a hazard on cultivated soils. Grassed waterways help to prevent the formation of gullies in many places. Interceptor tile helps to control seeps. Slopes are too steep for terracing. The return of all crop residue helps to maintain tilth and fertility.

The use of these soils for pasture effectively helps to control erosion. Overgrazing or grazing when the soils are wet causes compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotations, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

The soils in this complex are in capability subclass VIe.

95—Harps loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on convex rims around depressions on upland flats. Typically, individual areas are 4 to 20 acres, although some are much larger.

Typically, the surface layer is black loam about 6 inches thick. The subsurface layer is very dark gray clay loam about 12 inches thick. The subsoil is friable loam about 25 inches thick. It is olive gray and light brownish gray in the upper part, olive gray and light olive gray in the middle part, and grayish brown in the lower part. The substratum to a depth of about 60 inches is grayish brown loam.

Included with this soil in mapping are small areas of Canisteo soils on flats above the Harps soil. These soils have a lower lime content and are not so gray when they become dry. Also, there are Okoboji soils in small depressions. Inclusions make up 5 percent of this map unit.

Permeability of this Harps soil is moderate, and surface runoff is slow. This soil has a seasonal high water table. The available water capacity is high. The content of organic matter is about 4.5 to 5.5 percent in the surface layer. This soil is moderately alkaline throughout. The very high lime content of the surface layer increases the need for phosphorus and potassium fertilizer. The subsoil is very low in available phosphorus and available potassium. Tilth is good.

Most areas of this soil are cultivated. This soil is well suited to cultivated crops, hay, and pasture. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture if excess water is removed by tile drainage and plants are properly

fertilized. Phosphorus and potassium deficiencies are common because of the extremely high lime content of this soil.

This Harps soil is in capability subclass IIw.

107—Webster silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on upland flats and in drainageways. Individual areas are irregular in shape and range from 10 to more than 100 acres.

Typically, the surface layer is black silty clay loam about 5 inches thick. The subsurface layer is black and very dark gray silty clay loam about 15 inches thick. The subsoil is about 19 inches thick. The upper part of the subsoil is dark gray, mottled, friable silty clay loam; the middle part is olive gray, mottled, friable clay loam; and the lower part is grayish brown, mottled, friable clay loam. The substratum to a depth of about 60 inches is olive gray and grayish brown, mottled sandy loam. Some areas have dark or very dark gray colors that extend below a depth of 24 inches.

Included with this soil in mapping are small areas of Okoboji soils in depressions. These depressions are subject to ponding. Also included are small areas of Harps and Canisteo soils on the rims of depressions or flats. The Harps and Canisteo soils are high in content of lime. The included soils make up 5 to 10 percent of the map unit.

Permeability of this Webster soil is moderate, and surface runoff is slow. This soil has a seasonal high water table. The available water capacity is high. The surface layer is neutral, and the subsoil is neutral or mildly alkaline. The content of organic matter is about 6 to 7 percent in the surface layer. The subsoil is very low in available phosphorus and available potassium. This soil has fair tilth.

Most areas of this soil are cultivated. This soil is well suited to cultivated crops, hay, and pasture if artificially drained. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn and soybeans. Some slightly depressed areas become ponded during periods of heavy rainfall. This soil is slow to warm in the spring and tends to dry out and become cloddy and hard if worked when wet. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, helps to prevent excessive soil loss caused by wind erosion. Returning crop residue to the soil helps to maintain good tilth and increase water infiltration.

If used as pasture, overgrazing and grazing when the soil is wet causes surface compaction and decreased infiltration. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Webster soil is in capability subclass IIw.

118—Garwin silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on moderately wide, level divides and at heads of upland drains. Individual areas are 3 to over 100 acres in a broad, irregular pattern.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is silty clay loam about 9 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is friable silty clay loam about 31 inches thick. The subsoil is dark gray and gray in the upper part, olive gray in the middle part, and light olive gray in the lower part. The substratum to a depth of about 60 inches is light olive gray silty clay loam.

Included with this soil in mapping are small areas of Sperry soils in shallow depressions and a few calcareous spots of less than 2 acres. The Sperry soils are very poorly drained and contain a high amount of clay. In places, ponding drowns out cultivated crops. The crossable depressions have a slightly heavier surface texture and stay wet longer than typical Garwin soils. The calcareous spots are high in calcium carbonate and low in natural fertility. The inclusions make up about 10 percent of this map unit.

Permeability of this Garwin soil is moderate, and surface runoff is slow. The available water capacity is very high. This soil has a seasonal high water table. The content of organic matter is about 6 to 7 percent in the surface layer. The surface layer is medium acid to neutral. The subsoil is slightly acid or neutral. The subsoil is very low in available phosphorus and available potassium. This soil has fair tilth.

Most areas of this soil are cultivated. This soil is well suited to row crops, hay, and pasture. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn and soybeans if adequately drained. This soil is not subject to sheet and gully erosion.

This Garwin soil is in capability subclass IIw.

119—Muscatine silty clay loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is on moderately wide divides. Individual areas are 10 to over 100 acres in a broad, oblong pattern.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is silty clay loam about 10 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil is friable silty clay loam about 27 inches thick. It is very dark grayish brown and dark grayish brown in the upper part, dark grayish brown and grayish brown in the middle part, and grayish brown and light olive brown in the lower part. The substratum to a depth of about 60 inches is grayish brown silty clay loam.

Included with this soil in mapping are small areas of Garwin and Sperry soils. Garwin soils are poorly drained, low areas. Sperry soils are very poorly drained, depressional areas that is subject to ponding. These inclusions make up 5 to 10 percent of this map unit.

Permeability of this Muscatine soil is moderate, and surface runoff is slow. The available water capacity is very high. This soil has a seasonal high water table. The content of organic matter in the surface layer is 5 to 6 percent. The surface layer is slightly acid, unless the soil has been limed in the past few years. The subsoil is medium acid to neutral. The subsoil is low in available phosphorus and very low in available potassium. This soil has good tilth.

Most areas of this soil are used extensively for row crops. This soil is well suited to cultivated crops, hay, and pasture. It is poorly suited to sanitary facilities and moderately suited to building site development.

This soil is well suited to corn and soybeans. It has a seasonal high water table, especially in the spring. Tile drainage can improve the timeliness of fieldwork in years when the rainfall is above normal. Returning crop residue to the surface or regularly adding other organic material helps to improve fertility and maintain good tilth.

This Muscatine soil is in capability class I.

120—Tama silty clay loam, 0 to 2 percent slopes. This nearly level, well drained soil is on broad ridgetops and gently undulating divides. Individual areas are irregular in shape and 10 to 40 acres.

Typically, the surface layer is very dark brown silty clay loam about 7 inches thick. The subsurface layer is silty clay loam about 9 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The subsoil is friable silty clay loam about 31 inches thick. It is brown in the upper part, yellowish brown in the middle part, and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is brown silty clay loam.

Permeability of this soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter is about 3.5 to 4.5 percent in the surface layer. The surface layer is slightly acid. The subsoil is medium acid. The subsoil is medium in available phosphorus and very low in available potassium. This soil has fair tilth.

Areas of this soil are used intensively for row crops. This soil is well suited to cultivated crops, hay, and pasture. It is well suited to sanitary facilities and building site development.

This soil is well suited to corn and soybeans. It is not subject to sheet erosion or gully erosion. In most places, high density plant populations and adequate fertilizer show favorable returns.

This Tama soil is in capability class I.

120B—Tama silty clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on moderately broad, convex ridgetops and side slopes in uplands. Areas are moderately wide and range from 5 to over 100 acres.

Typically, the surface layer is very dark brown silty clay loam about 7 inches thick. The subsurface layer is silty clay loam about 9 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The subsoil is friable silty clay loam about 31 inches thick. It is brown in the upper part, yellowish brown in the middle part, and dark yellowish brown and yellowish brown in the lower part. The substratum to a depth of about 60 inches is brown silty clay loam that has a few light brownish gray mottles. In some areas near the heads of drainageways, mottling is at a depth as shallow as 20 inches.

Included with this soil in mapping are small areas of Garwin soils along the upper parts of drainageways. Garwin soils have a thicker, dark surface layer and are poorly drained. They make up 5 percent of this map unit.

Permeability of this Tama soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The surface layer is slightly acid. The subsoil is medium acid, medium in available phosphorus, and very low in available potassium. This soil has fair tilth.

Areas of this soil are used intensively for cultivated crops. This soil is well suited to cultivated crops, hay, and pasture. It is well suited to sanitary facilities and building site development.

This soil is well suited to corn and soybeans. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, tilling on the contour, stripcropping, and terracing are needed to reduce soil loss through erosion.

This Tama soil is in capability subclass IIe.

120C—Tama silty clay loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on convex ridgetops and moderately wide side slopes in uplands. Typical areas are irregular in shape and range from 5 to 80 acres.

Typically, the surface layer is very dark grayish brown silty clay loam about 10 inches thick. The subsoil is friable silty clay loam about 30 inches thick. It is dark brown and brown in the upper part and dark yellowish brown and yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown silty clay loam that has a few light brownish gray mottles.

Included with this soil in mapping are areas along the upper parts of drainageways that have a thicker, dark surface layer. These areas are somewhat poorly drained or poorly drained. They make up 5 percent of this map unit.

Permeability of this Tama soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter is about 3 to 3.5 percent in the surface layer. The surface layer is slightly acid. The subsoil is medium acid. The subsoil is medium in available phosphorus and very low in available potassium. This soil has fair tilth.

Areas of this soil are mostly cultivated and used intensively for row crops. This soil is moderately suited

to cultivated crops and well suited to hay and pasture. It is well suited to building site development and sanitary facilities.

This soil is moderately suited to corn and soybeans if they are used in the rotation system about one-half of the time. To help control erosion in cultivated fields, this soil needs conservation tillage in addition to contouring (fig. 10), stripcropping, or terracing (fig. 11). Conservation tillage, a practice that leaves crop residue on the surface throughout the year, also increases water infiltration and reduces the hazard of erosion. Grassed waterways are needed to prevent the formation of gullies. In many places, terrace drop inlets can be constructed.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Tama soil is in capability subclass IIIe.

120C2—Tama silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex ridgetops and moderately wide side slopes in uplands. Typical areas are irregular in shape and range from 5 to over 100 acres.

Typically, the surface layer is very dark brown silty clay loam that has mixing of dark brown and brown subsoil about 7 inches thick. The subsoil is friable silty clay loam about 30 inches thick. It is dark brown and brown in the upper part and dark yellowish brown or yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown silty clay loam that has a few light brownish gray mottles. In some areas, the surface layer is calcareous. In other areas, it is mainly brown silty clay loam.

Included with this soil in mapping are small areas of Adair and Shelby soils which outcrop on the lower downslope part of the area. Adair soils have a clay loam surface layer. Shelby soils are loamy rather than silty. Along the larger streams, a few areas have sandy spots that are more susceptible to wind erosion and have lower available water capacity. The inclusions make up 5 to 10 percent of this map unit.

Permeability of this Tama soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter is about 2.5 to 3 percent in the surface layer. The surface layer is slightly acid. The subsoil is medium acid. The subsoil is medium in available phosphorus and very low in available potassium. This soil has fair tilth.

Areas of this soil are mostly cultivated and used intensively for row crops. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is well suited to building site development and moderately suited to sanitary facilities.

This soil is moderately suited to corn and soybeans if they are used in the rotation system about one-half of the time. To help control erosion in cultivated fields, this soil needs conservation tillage, a practice that leaves crop residue on the surface throughout the year, in addition to contouring, stripcropping, or terracing. Conservation tillage also increases water infiltration. Grassed waterways are needed to prevent the formation of gullies. In many places, terrace drop inlets can be constructed (fig. 12).

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Tama soil is in capability subclass IIIe.

120D2—Tama silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex side slopes and nose slopes on uplands. Typically, individual areas are irregular in shape and range from 10 to 100 acres.

Typically, the surface layer is about 6 inches thick. It is very dark grayish brown silty clay loam that has some mixing of dark brown and brown subsoil. The subsoil is friable silty clay loam about 30 inches thick. The upper part of the subsoil is brown, and the lower part is yellowish brown and has a few grayish brown mottles. The substratum to a depth of about 60 inches is yellowish brown silty clay loam that has a few light brownish gray mottles. In some cove positions, the subsoil is light brownish gray. Some areas have a surface layer as much as 11 inches thick. In some areas, the surface layer is calcareous. In other areas, it is mainly brown silty clay loam.

Included with this soil in mapping are small areas of Adair and Shelby soils on downslope areas. Adair soils have a clay loam surface layer and Shelby soils are loamy rather than silty. Along larger streams, a few areas have sandy spots that are more susceptible to wind erosion and have lower available water capacity. The inclusions make up 5 to 10 percent of this map unit.

Permeability of this Tama soil is moderate, and surface runoff is rapid. The available water capacity is high. The content of organic matter is about 2 to 2.5 percent in the surface layer. The surface layer is slightly acid, and the subsoil is medium acid. The available phosphorus in the subsoil is medium, and the available potassium in the subsoil is very low. This soil has fair tilth.

Areas of this soil are generally cultivated and used intensively for row crops. The soil is moderately suited to cultivated crops and well suited to hay and pasture. It is moderately suited to septic tank filter fields, sewage lagoons, and building site development.

This soil is moderately suited to corn and soybeans, but these crops should be grown less than half of the

Figure 10.—Contour tillage reduces erosion on Tama silty clay loam, 5 to 9 percent slopes.

Figure 11.—Parallel terraces on Tama silty clay loam, 5 to 9 percent slopes, reduce soil loss.

Figure 12.—Tile intake terraces reduce erosion and prevent excess runoff.

time in a rotation system with oats and hay. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, and contouring, stripcropping, or terracing are needed to help control erosion on cultivated fields. Row crops can be included in the cropping pattern fairly often if fields are terraced and tilled on the contour. Grassed waterways are needed to prevent the formation of gullies, and in many places terrace drop inlets can be constructed. Conservation tillage will increase water infiltration.

The use of this soil for pasture and hay effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Tama soil is in capability subclass IIIe.

120E2—Tama silty clay loam, 14 to 18 percent slopes, moderately eroded. This moderately steep, well drained soil is on convex slopes along major

drainageways on uplands. Typically, areas are irregular in shape and range from 5 to 60 acres.

Typically, the surface layer, about 5 inches thick, is very dark grayish brown silty clay loam that has some mixing of the dark brown and brown subsoil. The subsoil is friable silty clay loam about 31 inches thick. It is brown in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown silty clay loam that has a few grayish brown mottles. In some cove positions, the subsoil is light brownish gray. In some areas, the surface layer is calcareous. In places, the surface layer is mainly brown silty clay loam.

Included with this soil in mapping are small areas of Adair and Shelby soils on downslope areas. Adair soils have a clay loam surface layer, and Shelby soils are loamy rather than silty. Along the larger streams, a few areas have sandy spots that are more susceptible to wind erosion and have lower available water capacity. The inclusions make up 5 to 10 percent of this map unit.

Permeability of this Tama soil is moderate, and surface runoff is rapid. The available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. The surface layer is slightly acid. The subsoil is medium acid, medium in available phosphorus, and very low in available potassium. This soil has fair tilth.

Areas of this soil are mostly cultivated. This soil is poorly suited to cultivated crops but is well suited to hay and pasture. It is poorly suited to sanitary facilities and moderately suited to building site development.

This soil is best suited to hay and pasture. This soil is poorly suited to corn and soybeans, but row crops can be used in rotation with hay and pasture. The use of this soil for oats, hay, and pasture effectively helps to control erosion. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, and stripcropping that leaves half of the area in meadow helps to control erosion. Conservation tillage and tilling on the contour also reduce runoff and increase water infiltration. Return of crop residue helps to maintain tilth and fertility. Terraces are not well suited to this soil. Slopes are steeper than desirable, and the low organic matter content restricts plant growth, especially in the terrace channels. In places, grassed waterways need to be tiled, reshaped, and seeded to permanent vegetation.

This Tama soil is in capability subclass IVe.

122—Sperry silt loam, 0 to 2 percent slopes. This nearly level, very poorly drained soil is in slight depressions on broad upland divides and broad stream benches. This soil is subject to ponding. Individual areas are elliptical and about 3 acres. Some areas up to 8 acres are irregular in shape.

Typically, the surface layer is black silt loam about 10 inches thick. The subsurface layer is very dark gray, dark gray, and gray silt loam about 12 inches thick. The subsoil, about 35 inches thick, is mottled gray, very firm silty clay and silty clay loam in the upper part and light gray, mottled, firm silty clay loam in the lower part. The substratum to a depth of about 60 inches is light gray, mottled silty clay loam.

Included with this soil in mapping on slightly higher positions are small areas of poorly drained Garwin soils and somewhat poorly drained Muscatine soils. Garwin and Muscatine soils have a silty clay loam surface layer. They make up 5 percent of this map unit.

Permeability of this Sperry soil is slow, and surface runoff is ponded. The available water capacity is high. This soil has a seasonal high water table. The content of organic matter is about 3 to 4 percent in the surface layer. The surface layer is slightly acid, unless the soil has been limed in the past few years. The subsoil is medium acid, and is very low in available phosphorus and available potassium. This soil has good tilth.

Most areas of this soil are used intensively for row crops. This soil is moderately suited to cultivated crops, hay, and pasture. It is poorly suited to sanitary facilities and building site development.

This soil is moderately suited to corn, soybeans, oats, hay, and pasture if drained. It is subject to ponding and has a high water table. Tile drains do not work in some places. Surface drains are needed to remove ponded water.

This Sperry soil is in capability subclass IIIw.

133—Colo silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on flood plains and on the lower parts of gently sloping upland drainageways. This soil is subject to occasional flooding. Individual areas are broad and range from 10 to 100 acres.

Typically, the surface layer is black silty clay loam about 11 inches thick. The subsurface layer is black silty clay loam about 26 inches thick. The next layer is very dark gray silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is light brownish gray silty clay loam. Some areas have 6 inches of very dark brown, silt loam overwash sediment. In some areas, the substratum is clay loam.

Permeability of this soil is moderate, and surface runoff is slow. The available water capacity is very high. This soil has a seasonal high water table. The content of organic matter is about 5 to 7 percent in the surface layer. Typically, the surface layer is neutral to medium acid and the subsurface layer and substratum are neutral or slightly acid. The substratum is generally medium in available phosphorus and very low in available potassium. The surface layer has fair tilth.

Most areas of this soil are cultivated. This soil is well suited to cultivated crops, hay, and pasture if adequately drained and if protected from flooding. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn and soybeans if it is drained and protected from flooding (fig. 13). Areas that are frequently flooded are used mainly for pasture. This

soil can be drained by tile and surface drains if adequate outlets are available. Diversions, levees, and channel improvements can help to provide flood protection and control runoff from adjacent areas. Artificial drainage helps to improve timeliness of operations.

This Colo soil is in capability subclass IIw.

133+—Colo silt loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on flood plains, on alluvial fans, and along tributaries of major streams. Areas of this soil are subject to frequent flooding. Individual areas on flood plains and alluvial fans are broad and range from 10 to 100 acres. Individual areas along tributary streams are long and narrow and range from 50 to 150 acres.

Typically, the surface layer is stratified, very dark grayish brown, dark grayish brown, and grayish brown silt loam overwash sediment about 10 inches thick. The subsurface layer is black silty clay loam about 27 inches thick. The next layer is very dark gray silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is very dark gray and dark gray silty clay loam. Small areas do not have silt loam overwash.

Figure 13.—An area of Colo silty clay loam, 0 to 2 percent slopes, along Linn Creek. Areas of this soil are subject to flooding.

Permeability of this soil is moderate, and surface runoff is slow. The available water capacity is high. This soil has a seasonal high water table. The content of organic matter in the surface layer is 3 to 5 percent. Typically, the surface layer is neutral to medium acid and the subsurface layer and substratum are neutral or slightly acid. The substratum is generally medium in available phosphorus and very low in available potassium. Typically, the surface layer has good tilth.

Most areas of this soil are cultivated. This soil is well suited to cultivated crops, hay, and pasture if adequately drained and protected from flooding. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn and soybeans if it is drained and protected from flooding. Areas that are frequently flooded are used mainly for pasture. This soil can be drained by tile and surface drains if adequate outlets are available. Diversions, levees, and channel improvements can help to provide flood protection and control runoff from adjacent areas. Artificial drainage helps to improve timeliness of operations.

This Colo soil is in capability subclass IIw.

133B—Colo silty clay loam, 2 to 5 percent slopes. This gently sloping, poorly drained soil is on foot slopes and in the lower parts of upland drainageways. Areas of this soil are subject to occasional flooding. Individual areas are long and narrow and range from 20 to 80 acres.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is black silty clay loam about 27 inches thick. The next layer is very dark gray silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is light brownish gray silty clay loam.

Permeability of this soil is moderate, and surface runoff is slow. The available water capacity is high. This soil has a seasonal high water table. The content of organic matter in the surface layer is 5 to 7 percent. Typically, the surface layer is neutral to medium acid, and the subsurface layer and substratum are neutral or slightly acid. The substratum is generally medium in available phosphorus and very low in available potassium. Typically, the surface layer has fair tilth.

Most areas of this soil are cultivated. This soil is well suited to cultivated crops if adequately drained and protected from flooding. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn and soybeans if it is drained and protected from flooding. Areas that are frequently flooded are used mainly for pasture. This soil can be drained by tile and surface drains if adequate outlets are available. Diversions, levees, and channel improvements can help to provide flood protection and divert runoff from adjacent areas. Artificial drainage helps to improve timeliness of operations and maintain tilth.

This Colo soil is in capability subclass IIw.

135—Coland silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on first bottoms and low benches. Areas of this soil are subject to occasional flooding. Individual areas are long and narrow and range from 10 to more than 100 acres.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer, about 20 inches thick, is black silty clay loam in the upper part and black clay loam in the lower part. The next layer is black clay loam 10 inches thick. The substratum is black clay loam to a depth of 60 inches. In places, sandy loam textured material is below a depth of 40 inches. Some areas have calcareous overwash up to 18 inches thick.

Included with this soil in mapping are a few small, depressional areas that contain more clay and that are subject to ponding. These soils make up 5 to 10 percent of the map unit.

Permeability of this Coland soil is moderate, and surface runoff is slow. This soil has a seasonal high water table. The available water capacity is very high. The surface layer is neutral. The content of organic matter in the surface layer is 5 to 7 percent. The subsoil is low in available phosphorus and very low in available potassium. This soil has fair tilth.

Most areas of this soil are cultivated. This soil is well suited to cultivated crops if artificially drained and if protected from flooding and runoff. This soil is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn and soybeans. Tile drainage works well in this soil if suitable outlets are available. This soil warms slowly in the spring and tends to dry out and become cloddy and hard if worked when wet. It dries out slowly in the spring because of the seasonal high water table. Returning crop residue helps to improve the tilth and increases water infiltration. Areas of this soil are subject to occasional flooding. Flooding commonly occurs early in the spring or is of short duration. Low lying areas and old bayous tend to pond after floods. Streambank cutting occurs in places.

If used for pasture, overgrazing or grazing when the soil is wet causes surface compaction and decreased infiltration. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Coland soil is in capability subclass IIw.

138B—Clarion loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex upland knolls. Typically, the slopes are short. Individual areas are irregular in shape and range from 10 to 100 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 7 inches thick. The subsoil is friable loam about 23 inches thick. The upper part is brown, the middle part is dark yellowish brown, and the lower part is yellowish brown. The substratum to a depth of about 60 inches is brown, calcareous loam. Some areas have

carbonates within a depth of 20 inches. In some areas, the substratum is sandy loam.

Included with this soil in mapping on lower areas are a few small areas of Nicollet and Webster soils that are somewhat poorly drained and poorly drained, and Storden soils that are calcareous throughout. Storden soils are on convex knobs. Included soils make up 5 to 10 percent of this map unit.

Permeability of this Clarion soil is moderate, and surface runoff is medium. The available water capacity is high. The surface layer is slightly acid or neutral. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil is very low in available phosphorus and available potassium. This soil has good tilth.

Most areas of this soil are cultivated. This soil is well suited to cultivated crops, hay, and pasture. It is well suited to septic tank filter fields and building site development.

This soil is well suited to corn and soybeans. When cultivated, water erosion and wind erosion are hazards. Soil loss can be reduced significantly by using conservation tillage, a practice that leaves crop residue on the surface throughout the year; contour farming; terraces; crop rotation; stripcropping; or a combination of these. Returning crop residue helps to maintain good tilth and increase water infiltration.

If used for pasture, overgrazing or grazing when the soil is wet causes surface compaction and increased runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Clarion soil is in capability class IIe.

138C—Clarion loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on knolls and convex side slopes that border streams and upland drainageways. Typically, the slopes are short. Individual areas are irregular in shape and range from 10 to 100 acres.

Typically, the surface layer is very dark brown loam about 7 inches thick. The subsurface layer is very dark grayish brown loam about 7 inches thick. The subsoil is brown, friable loam about 18 inches thick. The substratum to a depth of about 60 inches is yellowish brown, calcareous loam. Some areas have carbonates immediately below the surface layer. In some areas, the substratum is sandy loam.

Included with this soil in mapping on convex knobs are a few small areas of Storden soils that are calcareous throughout. They make up 5 percent of this map unit.

Permeability of this Clarion soil is moderate, and surface runoff is medium. The available water capacity is high. The surface layer is slightly acid or neutral. The content of organic matter in the surface layer is about 3 to 3.5 percent. The subsoil is very low in available phosphorus and available potassium. This soil has good tilth.

Most areas of this soil are cultivated. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is well suited to septic tank filter fields and building site development.

This soil is moderately suited to corn and soybeans. When cultivated, water erosion and wind erosion are hazards. Soil loss can be reduced significantly by using conservation tillage, contour farming, terraces, crop rotation, stripcropping, or a combination of these. Wind erosion can be reduced by conservation tillage, a practice that leaves crop residue on the surface throughout the year. Returning crop residue helps to maintain good tilth and increase water infiltration.

If used for pasture, overgrazing or grazing when the soil is too wet causes surface compaction and increased runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Clarion soil is in capability subclass IIIe.

138C2—Clarion loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on knolls and convex side slopes that border streams and upland drainageways. Typically, the slopes are short. Individual areas are irregular in shape and range from 10 to over 100 acres.

Typically, the surface layer is mixed very dark grayish brown and yellowish brown loam about 6 inches thick. The subsoil is friable loam about 14 inches thick. It is brown in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown calcareous loam. Some areas are calcareous immediately below the surface layer. In some areas, the substratum is sandy loam.

Included with this soil in mapping on convex knobs are a few small areas of Storden soils that are calcareous throughout. They make up 5 percent of this map unit.

Permeability of this Clarion soil is moderate, and surface runoff is medium. The available water capacity is high. The surface layer and the upper part of the subsoil are slightly acid or neutral. The content of organic matter in the plow layer is 2 to 2.5 percent. The subsoil is very low in available phosphorus and available potassium. This soil has good tilth.

Most areas of this soil are cultivated. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is well suited to septic tank filter fields and building site development.

This soil is moderately suited to corn and soybeans. When cultivated, erosion is a hazard. Soil loss can be reduced significantly by using a combination of such practices as conservation tillage, a practice that leaves crop residue on the surface throughout the year; contour farming; terraces; crop rotation; or stripcropping. Returning crop residue or regularly adding other forms of organic matter helps to improve fertility, reduce crusting, and increase water infiltration.

If used for pasture, overgrazing or grazing when the soil is wet causes surface compaction and increased runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Clarion soil is in capability subclass IIIe.

138D2—Clarion loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex side slopes on uplands. Typically, slopes are short. Individual areas are irregular in shape and range from 5 to 50 acres.

Typically, the surface layer is mixed dark brown, dark yellowish brown, and brown loam about 7 inches thick. The subsoil is yellowish brown, friable loam about 18 inches thick. The substratum to a depth of about 60 inches is yellowish brown, calcareous loam. In some areas, the substratum is sandy loam.

Included with this soil in mapping on convex knobs are a few small areas of Storden soils that are calcareous throughout. They make up 5 percent of this map unit.

Permeability of this Clarion soil is moderate, and surface runoff is medium. The available water capacity is high. The surface layer and the upper part of the subsoil are slightly acid or neutral. The content of organic matter in the surface layer is about 1 to 2 percent. The subsoil is very low in available phosphorus and available potassium. This soil has good tilth.

Most areas of this soil are cultivated. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is moderately suited to septic tank filter fields and building site development.

This soil is moderately suited to corn and soybeans. This soil is moderately eroded. If cultivated, erosion is a severe hazard. Soil loss can be reduced significantly by using a combination of such practices as conservation tillage, a practice that leaves crop residue on the surface throughout the year; contour farming; terraces; crop rotation; or stripcropping. Returning crop residue or regularly adding other forms of organic matter helps to improve fertility, reduce crusting, and increase water infiltration.

If used for pasture, overgrazing or grazing when the soil is wet causes surface compaction and increased runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Clarion soil is in capability subclass IIIe.

138E2—Clarion loam, 14 to 18 percent slopes, moderately eroded. This moderately steep, well drained soil is on convex side slopes on uplands. Typically, the slopes are short. Individual areas are irregular in shape and range from 5 to 50 acres.

Typically, the surface layer is mixed very dark grayish brown and brown loam about 7 inches thick. The subsoil is brown and yellowish brown, friable loam about 17 inches thick. The substratum to a depth of about 60 inches is yellowish brown calcareous loam. In some areas, the substratum is sandy loam.

Included with this soil in mapping on convex knobs are a few small areas of Storden soils that are calcareous throughout. They make up 5 percent of this map unit.

Permeability of this Clarion soil is moderate, and surface runoff is rapid. The available water capacity is high. The surface layer and the upper part of the subsoil are slightly acid or neutral. The content of organic matter in the plow layer is 0.5 to 1.5 percent. The subsoil is very low in available phosphorus and available potassium. This soil has good tilth.

Areas of this soil are used for cultivated crops, hay, and pasture. This soil is moderately suited to pasture but is poorly suited to hay and cultivated crops. It is poorly suited to sanitary facilities and building site development.

This soil is better suited to grasses and legumes than to other crops. It is poorly suited to corn and soybeans. If the soil is cultivated, erosion is a severe hazard.

Conservation tillage and stripcropping with half of the area in hay and pasture help to control erosion. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, increases water infiltration and helps to control runoff. Grassed waterways are needed to prevent the formation of gullies. Slopes are too steep for terracing. The return of all crop residue and other forms of organic matter help to improve fertility and reduce crusting.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Clarion soil is in capability subclass IVe.

150—Hanska loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on low stream benches. Areas of this soil are subject to rare flooding. Individual areas are irregular in shape and range from 3 to 100 acres.

Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is black loam about 6 inches thick. The subsoil is friable sandy loam about 21 inches thick. The upper part is dark gray, the middle part is gray, and the lower part is grayish brown. The substratum to a depth of about 60 inches is light brownish gray sand.

Included with this soil in mapping are small areas of somewhat poorly drained Lawler and well drained Saude soils and small marshy areas. The marshes are in depressional areas where the water table is at the surface. The Lawler and Saude soils are higher and not subject to flooding. Inclusions make up 5 to 10 percent of the map unit.

Permeability of this Hanska soil is moderately rapid in the upper part and rapid in the substratum. Surface runoff is slow. This soil has a seasonal high water table. The available water capacity is moderate. The content of organic matter in the surface layer is about 4 to 5.5 percent. The surface layer is neutral. The subsoil is neutral or slightly acid, low in available phosphorus, and very low in available potassium. Tilth is fair.

Most areas of this soil are cultivated. This soil is moderately suited to cultivated crops, hay, and pasture. It is poorly suited to sanitary facilities and building site development.

This soil is moderately suited to corn, soybeans, and pasture if drained. It can be drained by tile and surface drains if adequate outlets are available. Levees are used to control flooding. Artificial drainage improves tilth and the timeliness of field operations.

This Hanska soil is in capability subclass IIw.

162B—Downs silt loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex upland ridgetops and broad divides. Individual areas are irregular in shape and range from 5 to 40 acres.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is dark grayish brown and brown silt loam about 4 inches thick. The subsoil, about 35 inches thick, is dark yellowish brown, friable silt loam in the upper part. The middle part is yellowish brown, friable silty clay loam. The lower part is yellowish brown silty clay loam that has light brownish gray mottles. The substratum to a depth of about 60 inches is brown, light brownish gray, and strong brown silty clay loam.

Included with this soil in mapping along the major streams are small sandy areas. These areas have a fine sandy loam surface layer and a loamy sand substratum. They make up 5 percent of this map unit.

Permeability of this Downs soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The surface layer is medium acid, unless the soil has been limed in the past few years. The subsoil is medium acid or strongly acid. The subsoil is medium in available phosphorus and very low in available potassium. This soil has good tilth.

Areas of this soil are used for cultivated crops, trees, hay, and pasture. This soil is well suited to these uses. This soil is well suited to septic tank filter fields and building site development.

This soil is well suited to row crops if they are used in rotation with small grains and hay. If row crops are grown often in the rotation, tilling on the contour, stripcropping or terracing, and conservation tillage, a practice that leaves crop residue on the surface throughout the year, are needed to help reduce soil loss. These soils respond well to a high level of management.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees. A few small areas remain in native hardwoods. Natural and planted seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by careful site preparation or by spraying, cutting, or girdling. There are no hazards or limitations for planting or harvesting trees.

This Downs soil is in capability subclass IIe.

162C—Downs silt loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on narrow convex ridges and side slopes in uplands. Individual areas are irregular in shape and range from 10 to 70 acres.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam about 4 inches thick. The subsoil is silty clay loam about 34 inches thick. It is dark yellowish brown and brown and friable in the upper part and yellowish brown with a few grayish brown mottles in the lower part. The substratum to a depth of about 60 inches is brown, light brownish gray, and strong brown silty clay loam. In places, the surface layer is about 5 inches thick.

Included with this soil in mapping along the major streams are small sandy areas. These areas have a fine sandy loam surface layer and a loamy sand substratum. They make up 5 percent of this map unit.

Permeability of this Downs soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. The surface layer is medium acid, unless the soil has been limed in the past few years. The subsoil is medium acid or strongly acid, medium in available phosphorus, and very low in available potassium. This soil has good tilth.

Areas of this soil are used for cultivated crops, hay, pasture, and trees. This soil is moderately suited to cultivated crops and is well suited to hay, pasture, and trees. It is well suited to sanitary facilities and building site development.

This soil is moderately suited to corn and soybeans if they are used in rotation about one-half of the time. To help control erosion in cultivated fields, this soil needs conservation tillage and contouring, stripcropping, or terracing. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, also increases water infiltration and reduces the hazard of erosion. Grassed waterways prevent the formation of gullies. In many places, terrace drop inlets can be constructed.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases

runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees. A few small areas remain in native hardwoods. Natural and planted seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by careful site preparation or by spraying, cutting, or girdling. There are no hazards or limitations for planting or harvesting trees.

This Downs soil is in capability subclass IIIe.

162C2—Downs silt loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on narrow, convex ridges and side slopes in uplands. Individual areas are irregular in shape and range from 10 to 85 acres.

Typically, the surface layer is mixed very dark grayish brown, dark brown, and dark grayish brown silt loam about 5 inches thick. The subsoil is silty clay loam about 30 inches thick. It is brown and friable in the upper part and dark yellowish brown with grayish brown mottles in the lower part. The substratum to a depth of about 60 inches is brown, light brownish gray, and strong brown silty clay loam. In places, the surface layer is brown silty clay loam.

Included with this soil in mapping are small sandy areas along the major streams. These areas have a fine sandy loam surface layer and a loamy sand substratum. The inclusions make up 5 to 10 percent of this map unit.

Permeability of this Downs soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter is about 0.5 to 1.5 percent in the surface layer. The surface layer is strongly acid, unless the soil has been limed in the past few years. The subsoil is medium acid or strongly acid, medium in available phosphorus, and very low in available potassium. This soil has good tilth.

Areas of this soil are mostly cultivated and used intensively for row crops. This soil is moderately suited to cultivated crops and well suited to hay, pasture, and trees. This soil is moderately suited to sanitary facilities and building site development.

This soil is moderately suited to corn and soybeans if they are used in rotation with oats and hay. To help control erosion in cultivated fields, this soil needs conservation tillage, a practice that leaves crop residue on the surface throughout the year, in addition to contouring, stripcropping, or terracing. Conservation tillage also increases water infiltration and reduces the hazard of erosion. Grassed waterways prevent the formation of gullies. In many places, terrace drop inlets can be constructed.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees. A few small areas remain in native hardwoods. Natural and planted seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by careful site preparation or by spraying, cutting, or girdling. There are no hazards or limitations for planting or harvesting trees.

This Downs soil is in capability subclass IIIe.

162D—Downs silt loam, 9 to 14 percent slopes. This strongly sloping, well drained soil is mainly on convex side slopes in uplands. Individual areas are irregular in shape and range from 10 to 100 acres.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam about 3 inches thick. The subsoil is friable silty clay loam about 30 inches thick. It is brown in the upper part and yellowish brown with grayish brown mottles in the lower part. The substratum to a depth of about 60 inches is brown, light brownish gray, and strong brown silty clay loam. In places the surface layer is about 5 inches thick.

Included with this soil in mapping are small areas of poorly drained Colo, somewhat poorly drained Ely, and well drained Gara soils. The Colo and Ely soils are in drainageways. The Gara soils have a loam surface layer and are at lower elevations. These soils make up 10 to 15 percent of the map unit.

Permeability of this Downs soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter in the surface layer is about 1 to 2 percent. The surface layer is medium acid, unless the soil has been limed in the past few years. The subsoil is medium acid or strongly acid, medium in available phosphorus, and very low in available potassium. This soil has good tilth.

Areas of this soil are used for cultivated crops, trees, hay, and pasture. This soil is moderately suited to cultivated crops and well suited to hay, pasture, and trees. It is moderately suited to building site development and sanitary facilities.

This soil is moderately suited to corn and soybeans if they are used in rotation with oats and hay. To help control erosion in cultivated fields, this soil needs to be tilled on the contour, stripcropped, or terraced. Row crops can be included in the cropping system more often if soils are terraced and tilled on the contour. Grassed waterways prevent the formation of gullies. In many places, terrace drop inlets can be constructed. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, increases water infiltration and reduces the hazard of erosion.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases

runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees. A few small areas remain in native hardwoods. Natural and planted seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by careful site preparation or by spraying, cutting, or girdling. There are no hazards or limitations for planting or harvesting trees.

This Downs soil is in capability subclass IIIe.

162D2—Downs silt loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is mainly on convex side slopes and nose slopes in uplands. Individual areas are 10 to over 100 acres.

Typically, the surface layer is mixed very dark grayish brown, brown, and dark grayish brown silt loam about 5 inches thick. The subsoil is friable silty clay loam about 28 inches thick. It is brown in the upper part and yellowish brown with a few grayish brown mottles in the lower part. The substratum to a depth of about 60 inches is brown, light brownish gray, and strong brown silty clay loam. In places, the surface layer is brown silty clay loam.

Included with this soil in mapping are small areas of poorly drained Colo, somewhat poorly drained Ely, and well drained Gara soils. Colo and Ely soils are in drainageways. The Gara soils have a loam surface layer and are at lower elevations. These soils make up about 10 percent of this map unit.

Permeability of this Downs soil is moderate, and surface runoff is rapid. The available water capacity is high. The content of organic matter in the surface layer is about 1 to 2 percent. The surface layer is strongly acid, unless the soil has been limed in the past few years. The subsoil is medium acid or strongly acid, medium in available phosphorus, and very low in available potassium. This soil has good tilth.

Areas of this soil are used for cultivated crops, trees, hay, and pasture. This soil is moderately suited to cultivated crops and well suited to hay, pasture, and trees. This soil is moderately well suited to building site development but is well suited to other uses.

This soil is moderately suited to corn and soybeans if they are used in rotation with oats and hay. To help control erosion in cultivated fields, this soil needs to be tilled on the contour, stripcropped, or terraced. Row crops can be included in the cropping system more often if soils are terraced and tilled on the contour. Grassed waterways prevent the formation of gullies. In many places, terrace drop inlets can be constructed. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, increases water infiltration and reduces the hazard of erosion.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees. A few small areas remain in native hardwoods. Natural and planted seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by careful site preparation or by spraying, cutting, or girdling. There are no hazards or limitations for planting or harvesting trees.

This Downs soil is in capability subclass IIIe.

162E2—Downs silt loam, 14 to 18 percent slopes, moderately eroded. This moderately steep, well drained soil is mainly on convex side slopes in uplands. Individual areas are irregular in shape and range from 5 to 30 acres.

Typically, the surface layer is mixed dark grayish brown and brown silt loam about 6 inches thick. The subsoil is friable silty clay loam about 27 inches thick. It is brown in the upper part and yellowish brown with a few grayish brown mottles in the lower part. The substratum to a depth of about 60 inches is yellowish brown, light brownish gray, and strong brown silty clay loam. In places, the surface layer is brown silty clay loam.

Included with this soil in mapping are small areas of red clay and well drained Gara soils. The Gara soils have a loam surface layer and are at lower elevations. The areas of red clay are above the Gara soils. These inclusions make up less than 10 percent of the map unit.

Permeability of this Downs soil is moderate, and surface runoff is rapid. The available water capacity is high. The content of organic matter in the surface layer is less than 0.5 percent. The surface layer is slightly acid or medium acid, unless the soil has been limed in the past few years. The subsoil is medium acid or strongly acid, medium in available phosphorus, and very low in available potassium. This soil has good tilth.

This soil is poorly suited to cultivated crops. It is well suited to hay or pasture and moderately suited to woodland. This soil is moderately suited to building site development but is poorly suited to sanitary facilities.

Corn, soybeans, and oats generally are poorly suited, except to establish grasses and legumes. Slopes are too steep for terracing. Fields used for corn need to be stripcropped and tilled on the contour. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, reduces runoff and increases water infiltration. Some of the seeps at the heads of drains can be controlled by tile. Erosion control structures are needed to control some gullies and waterways.

The use of this soil for pasture or hay effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation,

timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is moderately suited to trees. Small areas remain in native hardwoods. Careful consideration should be given to the location of trails or roads used in logging on this soil in order to reduce the possibility of erosion. Laying out the trails or roads on the contour or nearly on the contour help to reduce soil erosion. The slope of this soil is steep enough so that some hazard is involved in the operation of equipment. Special equipment can be used, and caution should be exercised in its operation. The survival of seedlings or competition from undesirable plants should not be a problem.

This Downs soil is in capability subclass IVe.

163B—Fayette silt loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on moderately broad, convex ridgetops and side slopes in the uplands. Typical areas are moderately wide and regular in shape. They range from 20 to 60 acres.

Typically, the surface layer is very dark grayish brown silt loam about 4 inches thick. The subsurface layer is dark grayish brown and brown silt loam about 7 inches thick. The subsoil, about 42 inches thick, is dark yellowish brown, friable silt loam in the upper part; dark yellowish brown, friable silty clay loam in the middle part; and yellowish brown, friable silty clay loam in the lower part. The substratum to a depth of about 60 inches is yellowish brown silt loam.

Permeability of this soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter in the surface layer is 1 to 2 percent. The surface layer is medium acid, unless the soil has been limed in the past few years. The subsoil is very strongly acid or strongly acid. The subsoil is high in available phosphorus and very low in available potassium. This soil has good tilth.

Areas of this soil are mostly used for woodland and pasture. This soil is well suited to cultivated crops and to hay, pasture, and trees. It is well suited to septic tank filter fields and building site development.

This soil is well suited to corn, soybeans, oats, and hay. Erosion is a hazard. Oats and a mixture of alfalfa and bromegrass are useful in the cropping sequence. Where row crops are grown often in the rotation, conservation tillage, a practice that leaves crop residue on the surface throughout the year, increases water infiltration. Tilling on the contour and stripcropping are needed to prevent soil loss. Return of crop residue helps to maintain tilth. This soil responds well to high level management.

The use of this soil for pasture, hay, or trees effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees. A few small areas remain in native hardwoods. Natural and planted seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by careful site preparation or by spraying, cutting, or girdling. There are no hazards or limitations for planting or harvesting trees.

This Fayette soil is in capability subclass IIe.

163C—Fayette silt loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on narrow, convex ridgetops and side slopes in the uplands. Typical areas are irregular, long, and narrow in shape. They range from 10 to 30 acres.

Typically, the surface layer is very dark grayish brown silt loam about 4 inches thick. The subsurface layer is dark grayish brown silt loam about 6 inches thick. The subsoil is friable silty clay loam about 40 inches thick. It is brown in the upper part and dark yellowish brown in the middle and lower parts. The substratum to a depth of about 60 inches is yellowish brown silt loam. In places, the surface layer is very dark gray silt loam about 7 inches thick.

Permeability of this soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter in the surface layer is 1 to 1.5 percent. The surface layer is medium acid, unless the soil has been limed in the past few years. The subsoil is very strongly acid or strongly acid, high in available phosphorus, and very low in available potassium. The soil has good tilth.

Areas of this soil are mostly used for trees and pasture. This soil is moderately suited to cultivated crops, but is well suited to trees, pasture, and hay. This soil is well suited to septic tank filter fields and building site development.

This soil is moderately suited to corn and soybeans. If the soil is used for cultivated crops, erosion is a hazard. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, increases water infiltration. Contour stripcropping and terracing help to control runoff. The return of all crop residue will help to maintain tilth. Oats and a mixture of alfalfa and bromegrass are needed in the cropping sequence.

The use of this soil for pasture or hay effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees. A few small areas remain in native hardwoods. Natural and planted seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by careful site preparation or by spraying, cutting, or girdling. There are no hazards or limitations for planting or harvesting trees.

This Fayette soil is in capability subclass IIIe.

163D—Fayette silt loam, 9 to 14 percent slopes. This strongly sloping, well drained soil is on narrow ridgetops and side slopes in uplands. Typical areas are long, narrow, and irregular in shape and range from 10 to 100 acres.

Typically, the surface layer is very dark gray and very dark grayish brown silt loam about 4 inches thick. The subsurface layer is dark grayish brown silt loam about 6 inches thick. The subsoil is friable silty clay loam about 36 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown silt loam. In places, the surface layer is very dark brown silt loam about 7 inches thick. Some small areas have a thinner and lighter colored surface layer. The surface layer consists mainly of brown, former subsoil material, and is silty clay loam in these areas.

Included with this soil in mapping are small areas of poorly drained Colo, somewhat poorly drained Ely, and well drained Lindley soils. The Colo and Ely soils are in drainageways. The Lindley soils have a loam surface layer and are at lower elevations. These inclusions make up 10 to 15 percent of the map unit.

Permeability of this Fayette soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter in the surface layer is about 0.5 to 1 percent. The surface layer is medium acid, unless the soil has been limed in the past few years. The subsoil is very strongly acid or strongly acid. The subsoil is high in available phosphorus and very low in available potassium. The soil has good tilth.

Areas of this soil are used for trees, cultivated crops, oats, hay, and pasture. This soil is moderately suited to row crops, septic tank filter fields, and building site development, but is well suited to other uses.

This soil is moderately suited to corn and soybeans. If the soil is cultivated, erosion is a hazard. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, and tilling on the contour increase water infiltration. Contour stripcropping and terracing help to control runoff. The return of all crop residue helps to maintain tilth. Oats and a mixture of alfalfa and bromegrass are needed in the cropping sequence.

The use of this soil for pasture or hay effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees. A few small areas remain in native hardwoods. Natural and planted seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by careful site preparation or by spraying, cutting, or girdling. There are no hazards or limitations for planting or harvesting trees.

This Fayette soil is in capability subclass IIIe.

163E—Fayette silt loam, 14 to 18 percent slopes. This moderately steep, well drained soil is on convex side slopes of the uplands. Typical areas are long, narrow, and irregular in shape and range from 10 to 50 acres.

Typically, the surface layer is very dark gray silt loam about 3 inches thick. The subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil is friable silty clay loam about 34 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown silt loam.

Included with this soil in mapping are small areas of red clay and small areas of poorly drained Colo, somewhat poorly drained Ely, and well drained Lindley soils. The red clay areas are moderately well drained or somewhat poorly drained and have a clay loam surface layer and clay subsoil. Colo and Ely soils are in drainageways. Lindley soils have a loam surface layer and occur at a lower elevation. These inclusions make up about 5 to 10 percent of the map unit.

Permeability of this Fayette soil is moderate, and surface runoff is rapid. The available water capacity is high. The content of organic matter in the surface layer is 0.5 to 1 percent. The surface layer is medium acid, unless the soil has been limed in the past few years. The subsoil is very strongly acid or strongly acid, high in available phosphorus, and very low in available potassium. It has good tilth.

Areas of this soil are used for trees, hay, and pasture. This soil is poorly suited to row crops but is well suited to hay and pasture. It is moderately suited to trees. This soil is poorly suited to sanitary facilities and building site development.

This soil is poorly suited to corn and soybeans. It is susceptible to severe sheet and gully erosion. Corn and soybeans ordinarily are not used except to establish grasses and legumes. Slopes are too steep for terracing. Areas used for corn need to be stripcropped and tilled on the contour. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, reduces runoff and increases water intake. Soybeans should not be substituted for corn in the rotation. The return of all crop residue helps to maintain tilth. The addition of needed commercial fertilizer will benefit crop production. Some seeps at the heads of drains can be controlled by tile. Erosion control structures are needed to control some gullies and waterways.

The use of this soil for pasture or hay effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is moderately suited to trees. Small areas remain in native hardwoods. Careful consideration

should be given to the location of trails or roads used in logging on this soil in order to reduce the possibility of erosion. Laying out the trails or roads on the contour or nearly on the contour helps to reduce soil erosion. The slope of this soil is steep enough so that some hazard is involved in the operation of equipment. Special equipment can be used, and caution should be exercised in its operation. Survival of seedlings or competition from undesirable plants should not be a problem.

This Fayette soil is in capability subclass IVe.

163F—Fayette silt loam, 18 to 25 percent slopes. This steep, well drained soil is on convex side slopes on uplands. Typical areas are long, narrow, and irregular in shape and range from 5 to more than 20 acres.

Typically, the surface layer is very dark gray silt loam about 3 inches thick. The subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil is friable silty clay loam about 31 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown silt loam.

Included with this soil in mapping are small areas of poorly drained Colo, somewhat poorly drained Ely, and well drained Lindley soils. Colo and Ely soils are in drainageways. Lindley soils have a loam surface layer and are at lower elevations. These soils make up about 5 to 10 percent of the map unit.

Permeability of this Fayette soil is moderate, and surface runoff is rapid. The available water capacity is high. The content of organic matter in the surface layer is less than 0.5 percent. The surface layer is medium acid, unless the soil has been limed in the past few years. The subsoil is very strongly acid or strongly acid. The subsoil is high in available phosphorus and very low in available potassium. This soil has good tilth.

Areas of this soil are used for trees and pasture. This soil is generally unsuitable for cultivated crops but is moderately suited to oats, hay, and pasture. This soil is well suited to trees. It is poorly suited to sanitary facilities and building site development.

This soil is generally not suited to corn and soybeans. In most places, it is better suited to trees, hay, or pasture than other uses. This soil is susceptible to severe sheet and gully erosion. Oats generally are not suited except to establish grasses and legumes. Slopes are too steep for terracing. Erosion control structures are needed to control some gullies and waterways. The operation of farm machinery is difficult because of the steep slopes and the presence of gullies.

The use of this soil for pasture or hay effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition. Wooded areas need protection from grazing livestock.

This soil is well suited to trees. Small areas remain in native hardwoods. Careful consideration should be given to the location of trails or roads used in logging on this soil in order to reduce the possibility of erosion. Laying out the trails or roads on the contour or nearly on the contour helps reduce soil erosion. The slope of this soil is steep enough so that some hazard is involved in the operation of equipment. Special equipment can be used, and caution should be exercised in its operation. The survival of seedlings or competition from undesirable plants should not be a problem.

This Fayette soil is in capability subclass VIe.

175B—Dickinson fine sandy loam, 2 to 5 percent slopes. This gently sloping, well drained and somewhat excessively drained soil is on convex upland summits and on convex dunes on stream benches. Individual areas are broad and irregular in shape and range from 3 to 50 acres.

Typically, the surface layer is black fine sandy loam about 7 inches thick. The subsurface layer is fine sandy loam about 13 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil, about 28 inches thick, is dark brown, friable fine sandy loam in the upper part; brown and dark yellowish brown, friable fine sandy loam in the middle part; and yellowish brown, friable loamy sand in the lower part. The substratum to a depth of about 60 inches is brown loamy sand. In places, the surface layer is higher in clay and the subsoil is dark grayish brown. In places, the subsoil and substratum are silty clay loam.

Included with this soil in mapping are small areas of excessively drained Sparta soils. Sparta soils are more droughty and have less organic matter in the surface layer. They make up less than 10 percent of this map unit.

Permeability of this Dickinson soil is moderately rapid in the upper part and rapid in the lower part. Surface runoff is medium. The available water capacity is moderate. The content of organic matter in the surface layer is 1 to 2 percent. The surface layer is slightly acid to strongly acid, unless the soil has been limed in the past few years. The subsoil is very low in available phosphorus and available potassium. This soil has good tilth.

Areas of this soil are used for cultivated crops. Some areas are in trees, hay, and pasture. This soil is well suited to these uses. This soil is poorly suited to sanitary facilities but is well suited to building site development.

This soil is well suited to corn, soybeans, and oats. Erosion by wind is a hazard. Stripcropping and conservation tillage, a practice that leaves crop residue on the surface throughout the year, are needed to reduce soil loss. A good cover crop and grassed waterways help to prevent the formation of gullies.

This Dickinson soil is in capability subclass IIe.

175C—Dickinson fine sandy loam, 5 to 9 percent slopes. This moderately sloping, well drained and

somewhat excessively drained soil is on convex slopes of uplands and on convex slopes of dunes on high stream benches. Individual areas are broad and irregular in shape and range from 5 to 35 acres.

Typically, the surface layer is black fine sandy loam about 5 inches thick. The subsurface layer is fine sandy loam, about 13 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil, about 27 inches thick, is very dark grayish brown, friable fine sandy loam in the upper part; brown, friable fine sandy loam in the middle part; and yellowish brown, very friable loamy sand in the lower part. The substratum to a depth of about 60 inches is brown loamy sand. In places, the subsoil and substratum are silty clay loam. In places, the surface layer is dark grayish brown and the subsoil is fine sandy loam.

Included with this soil in mapping are small areas of excessively drained Sparta soils. Sparta soils are more droughty and have less organic matter in the surface layer. They make up less than 10 percent of this map unit.

Permeability of this Dickinson soil is moderately rapid in the upper part and rapid in the lower part. Surface runoff is medium, and the available water capacity is moderate. The content of organic matter in the surface layer is 1 to 1.5 percent. The surface layer is neutral or slightly acid. The subsoil is slightly acid to strongly acid, and very low in available phosphorus and available potassium. This soil has good tilth.

Areas of this soil are used for cultivated crops, trees, and some hay and pasture. This soil is moderately suited to these uses. It is poorly suited to sanitary facilities and moderately suited to building site development.

This soil is moderately suited to corn, soybeans, oats, hay, and pasture. Erosion by wind is a hazard (fig 14). Stripcropping and conservation tillage, a practice that leaves crop residue on the surface throughout the year, are needed to prevent soil loss. A good cover crop and grassed waterways help to prevent the formation of gullies.

This Dickinson soil is in capability subclass IIIe.

175D2—Dickinson fine sandy loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained and somewhat excessively drained soil is on convex side slopes of uplands. Individual areas are mostly narrow and range from 5 to 20 acres.

Figure 14.—Wind erosion on an area of Dickinson fine sandy loam, 5 to 9 percent slopes.

Typically, the surface layer, about 7 inches thick, is very dark grayish brown fine sandy loam with some mixing of dark brown and brown subsoil material. The subsoil, about 25 inches thick, is brown and dark yellowish brown, friable fine sandy loam in the upper part and yellowish brown, friable loamy sand in the lower part. The substratum to a depth of about 60 inches is brown loamy sand. In places, the surface layer is thinner and is dark grayish brown. Some areas have a surface layer about 13 inches thick.

Included with this soil in mapping on similar landscapes are small areas of excessively drained Sparta soils and well drained Tama soils. Sparta soils are more droughty and have less organic matter in the surface layer. Tama soils are silty and have high available water capacity. These soils make up less than 10 percent of this map unit.

Permeability of this Dickinson soil is moderately rapid in the upper part and rapid in the lower part. The surface runoff is medium. The available water capacity is moderate. The content of organic matter in the surface layer is less than 0.5 percent. The surface layer is slightly acid, unless the soil has been limed in the past few years. The subsoil is slightly acid to strongly acid. The subsoil is very low in available phosphorus and available potassium. This soil has good tilth.

Areas of this soil are used for cultivated crops and some trees, hay and pasture. This soil is poorly suited to these uses. This soil is poorly suited to sanitary facilities and moderately suited to building site development.

This soil is poorly suited to corn, soybeans, oats, hay, and pasture. Erosion by wind is a hazard. Stripcropping and conservation tillage, a practice that leaves crop residue on the surface throughout the year, help to reduce soil loss. A good cover crop and grassed waterways help to prevent the formation of gullies.

This Dickinson soil is in capability subclass IVe.

177—Saude loam, 1 to 3 percent slopes. This very gently sloping, well drained soil is on convex slopes of alluvial benches along streams and outwash areas. Individual areas are irregular in shape and range from 3 to 30 acres.

Typically, the surface layer is black loam about 6 inches thick. The subsurface layer is black and very dark brown loam about 8 inches thick. The subsoil, about 21 inches thick, is dark brown, friable loam in the upper part; dark brown, very friable sandy loam in the middle part; and dark yellowish brown, loose loamy sand in the lower part. The substratum to a depth of about 60 inches is yellowish brown and dark yellowish brown gravelly loamy sand and gravelly sandy loam.

Included with this soil in mapping are small areas of somewhat poorly drained Lawler soils and well drained Waukee soils. Lawler soils are on more level landscapes. Waukee soils are on similar landscapes. Lawler and Waukee soils have more clay in the upper part of the subsoil and tend to be deeper to sand and gravel. They make up 5 percent of this map unit.

Permeability of this Saude soil is moderate in the upper part and very rapid in the underlying coarse textured materials. The available water capacity is moderate, and surface runoff is medium. The content of organic matter in the surface layer is about 2.5 to 3.5 percent. The surface layer is slightly acid, unless the soil has been limed in the past few years. The subsoil is medium acid, low in available phosphorus, and very low in available potassium. This soil has good tilth.

Most areas of this soil are in cropland, but some areas are in pasture. This soil is well suited to cultivated crops, hay, and pasture. It is poorly suited to sanitary facilities and well suited to building site development.

This soil is well suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. Some areas, small in size, are cropped with adjacent soils. The Saude soils are higher than the adjacent first bottom lands and normally do not flood. The use of this soil for pasture or hay effectively helps to control erosion. The moderate available water capacity limits crop yields.

This Saude soil is in capability subclass IIs.

177C2—Saude loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex slopes of escarpments on alluvial benches along streams. Individual areas are narrow, irregular bands and range from 3 to 25 acres.

Typically, the surface layer is very dark brown and brown loam about 7 inches thick. The subsoil is about 17 inches thick. The upper part is brown friable loam and sandy loam, and the lower part is dark yellowish brown, loose loamy sand. The substratum to a depth of about 60 inches is brown gravelly loamy sand. In places, depth to gravelly loamy sand is as shallow as 10 inches.

Included with this soil in mapping are small areas of gravelly coarse sand. These areas have lower available water capacity and are lower in organic matter content. They are on nose slopes of escarpments and make up about 5 percent of the map unit.

Permeability of this Saude soil is moderate in the upper part and very rapid in the underlying coarse textured materials. The available water capacity is moderate, and surface runoff is medium. The content of organic matter in the surface layer is 1.5 to 2.5 percent. The surface layer is slightly acid unless the soil has been limed in the past few years. The subsoil is medium acid, low in available phosphorus, and very low in available potassium. This soil has good tilth.

Most areas of this soil are in cropland, but some areas are in pasture. This soil is moderately suited to cultivated crops, hay, and pasture. It is poorly suited to sanitary facilities and moderately suited to building site development.

This soil is moderately suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. Some areas, small in size, are cropped with adjacent soils. The Saude soils are higher than the adjacent first bottom lands and normally do not flood. The use of this

soil for pasture or hay effectively helps to control erosion. The moderate available water capacity limits crop yields.

This Saude soil is in capability subclass IIIe.

178—Waukee loam, 1 to 3 percent slopes. This very gently sloping, well drained soil is on convex slopes of alluvial benches along streams and outwash areas. Individual areas are irregular in shape and range from 3 to 20 acres.

Typically, the surface layer is very dark brown loam about 7 inches thick. The subsurface layer is loam about 10 inches thick. It is very dark brown in the upper part and very dark grayish brown and dark brown in the lower part. The subsoil is friable loam about 23 inches thick. It is brown and dark brown in the upper part, dark yellowish brown in the middle part, and yellowish brown in the lower part. The substratum to a depth of about 60 inches is brown and yellowish brown gravelly loamy sand and gravelly sand. In places, the combined thickness of surface layer and subsurface layer is about 30 inches.

Included with this soil in mapping are small areas of somewhat poorly drained Lawler and well drained Saude soils. Lawler soils are on more level landscapes and have dark grayish brown colors in the upper part of the subsoil. Saude soils are on similar landscapes, are more shallow to sand and gravel, and are droughty. These soils make up 5 to 10 percent of this map unit.

Permeability of this Waukee soil is moderate in the surface layer and subsoil and very rapid in the substratum. The available water capacity is moderate, and surface runoff is medium. The content of organic matter in the surface layer is 3 to 4 percent. The surface layer is neutral. The subsoil is medium acid, low in available phosphorus, and very low in available potassium. Tilth is good.

Areas of this soil are used for cultivated crops, hay, and pasture. This soil is well suited to these uses. It is poorly suited to sanitary facilities and well suited to building site development.

This soil is well suited to corn, soybeans, hay, and pasture. It is not subject to sheet and gully erosion. The moderate available water capacity limits crop yields in some years.

This Waukee soil is in capability class I.

179E—Gara loam, 14 to 18 percent slopes. This moderately steep, moderately well drained and well drained soil is on convex side slopes. Individual areas are irregular in shape and range from 3 to 15 acres.

Typically, the surface layer is very dark grayish brown loam about 6 inches thick. The subsurface layer is dark grayish brown loam about 5 inches thick. The subsoil is firm clay loam about 35 inches thick. The upper part is dark yellowish brown and yellowish brown, and the lower part is yellowish brown. The substratum to a depth of about 60 inches is yellowish brown, mottled clay loam. In places where the subsoil has been mixed with the surface and subsurface layers by plowing, the surface layer is dark brown clay loam.

Included with this soil in mapping are small areas of somewhat poorly drained, reddish brown, clayey soils. These soils are high on the side slope, and water seeps during extended wet periods. These inclusions make up about 5 percent of the map unit.

Permeability of this Gara soil is moderately slow, and surface runoff is rapid. The available water capacity is high. The content of organic matter in the surface layer is about 1 to 2 percent. The surface layer is neutral to medium acid. The subsoil is medium acid to very strongly acid, very low to low in available phosphorus, and very low in available potassium. This soil has good tilth.

Areas of this soil are used for trees and pasture. This soil is generally unsuitable for cultivated crops and is moderately suited to hay, pasture, and trees. It is poorly suited to sanitary facilities and building site development.

This soil is moderately suited to hay and pasture. Permanent vegetation effectively helps to control sheet and gully erosion. Slopes are too steep to terrace. Controlled grazing is necessary to prevent serious damage to vegetation.

This soil is moderately suited to trees. Small areas remain in native hardwoods. Careful consideration should be given to the location of trails or roads used in logging on this soil in order to reduce the possibility of erosion. Laying out the trails or roads on the contour or nearly on the contour helps to reduce soil erosion. The slope of this soil is steep enough so that some hazard is involved in the operation of equipment. Special equipment can be used, and caution should be exercised in its operation. Survival of seedlings or competition from undesirable plants should not be a problem.

This Gara soil is in capability subclass VIe.

179E2—Gara loam, 14 to 18 percent slopes, moderately eroded. This moderately steep, moderately well drained and well drained soil is on dissected, convex side slopes. Individual areas are irregular in shape and range from 3 to 40 acres.

Typically, the surface layer is mixed dark brown and dark yellowish brown loam about 7 inches thick. The subsoil is firm clay loam about 26 inches thick. It is dark yellowish brown in the upper part, yellowish brown in the middle part, and light brownish gray and yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, calcareous clay loam. In places, there is a subsurface layer of dark grayish brown loam.

Included with this soil in mapping are small areas of somewhat poorly drained, reddish brown, clayey soils and small areas of sandstone bedrock. The reddish brown clayey soils are high on the side slope, and water seeps during extended wet periods. The inclusions make up 10 percent of the map unit.

Permeability of this Gara soil is moderately slow, and surface runoff is rapid. The available water capacity is

high. The content of organic matter in the surface layer is 0.5 to 1 percent. The surface layer is neutral to medium acid. The subsoil is medium acid to very strongly acid, very low to low in available phosphorus, and very low in available potassium. This soil has fair tilth.

Areas of this soil are used for trees, pasture, cultivated crops, and hay. This soil is generally unsuitable for cultivated crops but is moderately suited to hay, pasture, and trees. It is poorly suited to sanitary facilities and building site development.

This soil is moderately suited to grasses and legumes for hay and pasture. Permanent vegetation effectively helps to control sheet and gully erosion. Slopes are too steep to terrace.

Controlled grazing is necessary to prevent serious damage to vegetation. Trees need to be protected from grazing livestock. Fertilization of this soil will improve the wildlife habitat, maintain yields, and maintain or improve soil tilth. If the soil is used for cultivated crops, there is a hazard of further erosion damage. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, effectively helps to prevent excessive soil loss. Grassed waterways help to prevent gully erosion.

This soil is moderately suited to trees. Small areas remain in native hardwoods. Careful consideration should be given to the location of trails or roads used in logging on this soil in order to reduce the possibility of erosion. Laying out the trails or roads on the contour or nearly on the contour helps to reduce soil erosion. The slope of this soil is steep enough so that some hazard is involved in the operation of equipment. Special equipment can be used, and caution should be exercised in its operation. Survival of seedlings or competition from undesirable plants should not be a problem.

This Gara soil is in capability subclass VIe.

179F—Gara loam, 18 to 25 percent slopes. This steep, moderately well drained and well drained soil is on dissected side slopes that border upland drainageways. Typically, individual areas are elongated and range from 3 to 25 acres.

Typically, the surface layer is very dark grayish brown loam about 6 inches thick. The subsurface layer is dark grayish brown loam about 5 inches thick. The subsoil is firm clay loam about 28 inches thick. It is dark yellowish brown in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, calcareous clay loam.

Included with this soil in mapping are small areas of red clay, gray clay, sandstone, and Chelsea and Downs soils. The somewhat poorly drained, reddish brown clayey soils and the poorly drained, dark gray clayey soils are high on the side slope, and water seeps during extended wet periods. The Chelsea soils have less organic matter in the surface layer. Chelsea soils are also lower in available water capacity. The Downs soils are on narrow ridgetops, are more permeable, and are higher in available water capacity. The inclusions make up about 10 percent of this map unit.

Permeability of this Gara soil is moderately slow, and surface runoff is rapid. The available water capacity is high. The content of organic matter in the surface layer is less than 0.5 percent. The surface layer is neutral to medium acid. The subsoil is medium acid to very strongly acid, very low to low in available phosphorus, and very low in available potassium. This soil has good tilth.

Areas of this soil are used for trees and pasture. This soil is generally unsuitable for cultivated crops. It is moderately suited to pasture, hay, and trees. This soil is poorly suited to sanitary facilities and building site development.

This soil is moderately suited to grasses and legumes for hay and pasture. It is generally unsuitable for cultivated crops because of the steep slopes. Permanent vegetation effectively helps to control sheet and gully erosion. Controlled grazing is necessary to prevent serious damage to vegetation.

This soil is moderately suited to trees. Small areas remain in native hardwoods. Careful consideration should be given to the location of trails or roads used in logging on this soil in order to reduce the possibility of erosion. Laying out the trails or roads on the contour or nearly on the contour helps to reduce soil erosion. The slope of this soil is steep enough so that some hazard is involved in the operation of equipment. Special equipment can be used, and caution should be exercised in its operation. Survival of seedlings or competition from undesirable plants should not be a problem.

This Gara soil is in capability subclass VIe.

192D2—Adair clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, moderately well drained and somewhat poorly drained soil is on upland nose slopes and convex side slopes. Individual areas are elongated and are 4 to 20 acres.

Typically, the surface layer is mixed very dark gray and brown clay loam about 6 inches thick. The subsoil to a depth of about 60 inches is brown, friable clay loam in the upper part; reddish brown and yellowish red, mottled, very firm silty clay in the middle part; and yellowish brown, mottled, firm clay loam in the lower part. In places, the surface layer is brown clay loam.

Included with this soil in mapping are small areas of well drained and moderately well drained Shelby soils and well drained Tama soils. Tama soils are upslope and Shelby soils are downslope from the Adair soil. These inclusions make up about 5 percent of this unit.

Permeability of this Adair soil is slow, and surface runoff is rapid. This soil has a seasonal high water table. Seepy, wet spots are common near the contact with loess soils upslope. The available water capacity is moderate. The content of organic matter in the surface layer is about 1.5 to 2.5 percent. The surface layer is neutral to medium acid. The subsoil is slightly acid to strongly acid, very low in available phosphorus, and low

to very low in available potassium. This soil has poor tilth.

Areas of this soil are used for permanent pasture or hay. Some areas are cultivated for row crops. This soil is poorly suited to cultivated crops, hay, and pasture. It is poorly suited to sanitary facilities and building site development.

The use of this soil for pasture and hay effectively helps to control erosion. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, reduces runoff and increases water infiltration. The return of all crop residue helps to maintain tilth and fertility. Interceptor tile can be used in seepy and wet areas. In places, waterways need to be shaped and seeded to permanent vegetation.

This Adair soil is in capability subclass IVe.

201B—Coland-Terril complex, 2 to 5 percent slopes. This map unit consists of gently sloping, poorly drained and moderately well drained soils on foot slopes, alluvial fans, and narrow flood plains. Most areas are along small streams in the western one-third of the county. Individual areas of this complex are long and very narrow. They range from 5 to 40 acres.

Mapped areas contain 60 to 75 percent Coland soil and about 25 percent Terril soil. The poorly drained Coland soil is near the stream channels. The Coland soil in this complex is subject to frequent flooding. The Terril soil is upslope from the Coland soil and is not subject to flooding. The individual soil areas are so small that it is not practical to separate them in mapping.

Typically, the Coland soil has a surface layer of black silty clay loam about 10 inches thick. The subsurface layer, about 20 inches thick, is black silty clay loam in the upper part and black clay loam in the lower part. The next layer is black clay loam about 10 inches thick. The substratum to a depth of about 60 inches is gray loam. In places, the substratum is sandy loam. Some areas have calcareous overwash up to 18 inches thick.

Typically, the Terril soil has a surface layer of black loam about 9 inches thick. The subsurface layer is loam about 13 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The subsoil to a depth of about 60 inches is brown, friable loam grading to dark yellowish brown, very friable sandy loam.

Included in this complex are a few small depressional areas that are subject to ponding. These areas make up 5 to 10 percent of this complex.

Permeability of the Coland and Terril soils is moderate. Runoff is medium. The available water capacity is very high for the Coland soil and high for the Terril soil. The Coland soil has a seasonal high water table. The surface layer of the Coland soil is neutral, and the surface layer of the Terril soil is neutral or slightly acid. The content of organic matter in the surface layer is about 4 to 6 percent in the Coland soil and 4 to 5 percent in the Terril soil. The available phosphorus is low in the Coland soil and very low in the Terril soil. The available potassium is very low in the Coland soil and low to very low in the Terril soil. The Coland soil has fair tilth, and the Terril soil has good tilth.

Most areas of these soils are cultivated, but some areas are in pasture or grassed waterways. These soils are well suited to cultivated crops, hay, and pasture. They are poorly suited to sanitary facilities and building site development.

These soils are well suited to corn and soybeans. Individual areas that are small are cropped with adjacent soils in most places. Maintaining grassed waterways on these soils is an effective method of controlling erosion and gullying. Some areas are subject to runoff from side slopes, which causes siltation. Other areas are subject to short duration flooding from small streams. In places, diversions and channel improvements provide flood protection and divert runoff from adjacent side slopes. Artificial drainage helps to improve timeliness of operations and maintain tilth.

The use of these soils for pasture or hay effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poorer tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods helps to keep the pasture and soil in good condition.

The soils of this complex are in capability subclass IIw.

220—Nodaway silt loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on first bottom lands adjacent to major streams and tributaries and on alluvial fans. In areas where the stream has been straightened, Nodaway soils are along the old channels. Areas of this soil are subject to flooding. Individual areas are long and moderately wide and are 10 to more than 200 acres.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. Below the surface layer to a depth of about 57 inches is a stratified, silt loam substratum. It is very dark gray, very dark grayish brown, dark grayish brown, and grayish brown. The underlying layer to a depth of about 60 inches is black silty clay loam buried soil. In places, only 24 inches of stratified silt loam sediment covers the buried soil.

Included with this soil in mapping are small areas of Colo soils. They are poorly drained and are on lower parts of the bottom lands that have not received recent deposits of silty sediment. The Colo soils make up 5 percent of this map unit.

Permeability of this Nodaway soil is moderate, and surface runoff is slow. This soil has a seasonal high water table. The available water capacity is very high. The content of organic matter in the surface layer is 1 to 2 percent. Typically, the surface layer and substratum are neutral. The substratum is generally medium in available phosphorus and low in available potassium. This soil has good tilth.

Most areas of this soil are in cultivated crops. This soil is well suited to cultivated crops, hay, pasture, and trees.

It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. Most areas of this soil are suited to intensive row cropping if they are adequately protected from flooding. Most flooding occurs before crops are planted. Levees and dikes provide flood protection. Tile drains function well if adequate outlets are available.

This soil is well suited to trees. A few small areas remain in native hardwoods. Natural and planted seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by careful site preparation or by spraying, cutting, or girdling. There are no hazards or limitations for planting or harvesting trees.

This Nodaway soil is in capability subclass IIw.

222D2—Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, poorly drained soil is on convex side slopes and in coves at heads of drainageways. Individual areas are irregular in shape and are 5 to 25 acres.

Typically, the surface layer is mixed very dark grayish brown and brown silty clay loam about 6 inches thick. The subsurface layer is brown and grayish brown silty clay loam about 8 inches thick. The subsoil to a depth of about 60 inches is gray, mottled, very firm silty clay in the upper part and mottled, very firm clay in the lower part. In places, the surface layer is less than 3 inches thick.

Included with this soil in mapping are small areas of well drained and moderately well drained Shelby and Killduff soils and well drained Tama soils. The Shelby soils are at lower elevations. The Killduff and Tama soils are at higher elevations. These inclusions make up about 10 percent of this map unit.

Permeability of this Clarinda soil is very slow, and surface runoff is rapid. This soil has a seasonal high water table. The available water capacity is high. The content of organic matter in the surface layer is 1.5 to 2 percent. The surface layer is slightly acid, unless the soil has been limed in the past few years. The subsoil is slightly acid, low in available phosphorus, and low in available potassium. Tilth is poor.

Areas of this soil are used for permanent pasture or hay, and some areas are cultivated for row crops. This soil is poorly suited to cultivated crops, hay, and pasture. It is poorly suited to sanitary facilities and building site development.

The use of this soil for pasture and hay effectively helps to control erosion. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, reduces runoff and increases water infiltration. Returning crop residue helps to maintain tilth and fertility. Interceptor tile can be used in seepy and wet areas. In places, waterways need to be shaped and seeded to permanent vegetation.

This Clarinda soil is in capability subclass IVe.

226—Lawler loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on alluvial benches and outwash plains. Individual areas are irregular in shape and range from 5 to 80 acres.

Typically, the surface layer is black loam about 6 inches thick. The subsurface layer is very dark gray and very dark grayish brown loam about 10 inches thick. The subsoil is about 20 inches thick. It is dark grayish brown, friable sandy clay loam in the upper part; dark grayish brown and grayish brown, friable sandy clay loam in the middle part; and grayish brown, friable loamy sand in the lower part. The substratum to a depth of about 60 inches is mottled, grayish brown and brown sand.

Included with this soil in mapping are small areas of Hanska, Saude, and Spillville soils. The Hanska soils are poorly drained and are in narrow drainageways. The Saude soils are well drained and are on convex slopes. The Spillville soils are on adjacent bottom lands and are commonly flooded. These soils make up 5 to 10 percent of this map unit.

Permeability of this Lawler soil is moderate in the upper part and rapid in the underlying coarse textured material. The available water capacity is moderate, and surface runoff is slow. This soil has a seasonal high water table. The content of organic matter in the surface layer is 4 to 5 percent. The surface layer is slightly acid, unless the soil has been limed in the past few years. The subsoil is medium acid. The available phosphorus and available potassium in the subsoil are very low. This soil has good tilth.

Most areas of this soil are cultivated. This soil is well suited to cultivated crops, hay, and pasture. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn, soybeans, hay, and pasture. This soil is slightly higher in elevation than the adjacent bottom lands and does not become flooded. The moderate available water capacity limits crop yields in some years.

This Lawler soil is in capability subclass IIs.

236C—Lester loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on convex upland knolls and ridgetops. Typically, the slopes are short. Individual areas are irregular in shape and range from 5 to 20 acres.

Typically, the surface layer is very dark grayish brown, loam about 6 inches thick. The subsoil, about 24 inches thick, is brown, firm clay loam in the upper part; yellowish brown, firm clay loam in the middle part; and dark yellowish brown, firm loam in the lower part. The substratum to a depth of about 60 inches is yellowish brown loam.

Included with this soil in mapping are small areas that are less sloping. They make up about 10 percent of this map unit.

Permeability of this soil is moderate, and surface runoff is medium. The available water capacity is high. Reaction is medium acid or slightly acid in the surface layer, unless the soil has been limed in the past few years. The content of organic matter in the plow layer is 2 to 3 percent. In the subsoil the available phosphorus is medium, and the available potassium is very low. This soil has good tilth.

Most areas of this soil are cultivated. This soil is moderately suited to cultivated crops and well suited to woodland, hay, and pasture. This soil is well suited to septic tank filter fields and building site development.

This soil is moderately suited to corn and soybeans. If cultivated, water erosion and wind erosion are hazards. Soil loss can be reduced significantly by using a combination of such practices as conservation tillage, a practice that leaves crop residue on the surface throughout the year; contour farming; terraces; crop rotation; or stripcropping. Returning crop residue or regularly adding other forms of organic matter helps to improve fertility, reduce crusting, and increase water infiltration.

When used for pasture, overgrazing or grazing when the soil is wet causes surface compaction and increased runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees. A few small areas remain in native hardwoods. Few problems should be encountered in planting new stands of trees if proper species are selected and managed properly.

This Lester soil is in capability subclass IIIe.

236C2—Lester loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex upland knolls and ridgetops. Typically, the slopes are short. Individual areas are irregular in shape and range from 5 to 40 acres.

Typically, the surface layer is mixed very dark grayish brown, dark brown, and brown loam about 6 inches thick. The subsoil, about 24 inches thick, is brown, firm clay loam in the upper part and dark yellowish brown, firm loam in the lower part. The substratum to a depth of 60 inches is yellowish brown loam. In places, the surface layer is brown clay loam.

Permeability of this soil is moderate, and surface runoff is medium. The available water capacity is high. The surface layer is slightly acid or medium acid, unless the soil has been limed in the past few years. The content of organic matter in the plow layer is 1 to 2 percent. In the subsoil the available phosphorus is medium, and the available potassium is very low. This soil has good tilth.

Most areas of this soil are cultivated. This soil is moderately suited to cultivated crops and well suited to woodland, hay, and pasture. This soil is well suited to septic tank filter fields and moderately suited to building site development.

This soil is moderately suited to corn and soybeans. If cultivated, water erosion and wind erosion are hazards. Soil loss can be reduced significantly by using a combination of such practices as conservation tillage, a practice that leaves crop residue on the surface throughout the year; contour farming; terraces; crop rotation; or stripcropping. Returning crop residue or regularly adding other forms of organic matter helps to improve fertility, reduce crusting, and increase water infiltration.

If used for pasture, overgrazing or grazing when the soil is wet causes surface compaction and increased runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees. A few small areas remain in native hardwoods. Few problems should be encountered in planting new stands of trees if proper species are selected and managed properly.

This Lester soil is in capability subclass IIIe.

236D2—Lester loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex upland side slopes and knolls. Typically, the slopes are short. Individual areas are irregular in shape and range from 5 to 60 acres.

Typically, the surface layer is mixed very dark grayish brown and grayish brown loam about 6 inches thick. The subsoil is about 32 inches thick. The upper part is dark brown and brown, firm clay loam; the middle part is dark yellowish brown, firm clay loam; and the lower part is yellowish brown, firm loam. The substratum to a depth of about 60 inches is yellowish brown loam. In places, the surface layer is brown clay loam.

Permeability of this soil is moderate, and surface runoff is medium. The available water capacity is high. The surface layer is slightly acid or medium acid, unless the soil has been limed in the past few years. The content of organic matter in the surface layer is about 0.5 to 1.5 percent. In the subsoil available phosphorus is medium, and the available potassium is very low. This soil has good tilth.

Most areas of this soil are cultivated. This soil is moderately suited to cultivated crops and well suited to woodland, hay, and pasture. It is poorly suited to septic tank filter fields and building site development.

This soil is moderately suited to corn and soybeans. If cultivated, water erosion and wind erosion are hazards. Soil loss can be reduced significantly by using a combination of such practices as conservation tillage, a practice that leaves crop residue on the surface throughout the year; contour farming; terraces; crop rotation; or stripcropping. Wind erosion can be reduced by conservation tillage or by leaving all crop residue on the surface. Returning crop residue or regularly adding other forms of organic matter helps to improve fertility, reduce crusting, and increase water infiltration.

If used for pasture, overgrazing or grazing when the soil is wet causes surface compaction and increased runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees. A few small areas remain in native hardwoods. Few problems should be encountered in planting new stands of trees if proper species are selected and managed properly.

This Lester soil is in capability subclass IIIe.

236E—Lester loam, 14 to 18 percent slopes. This moderately steep, well drained soil is on convex upland side slopes. Typically, these slopes are short. Individual areas are irregular in shape and range from 10 to 100 acres.

Typically, the surface layer is very dark gray and very dark grayish brown loam about 6 inches thick. The subsurface layer is very dark grayish brown and grayish brown loam about 3 inches thick. The subsoil, about 31 inches thick, is dark brown, firm clay loam in the upper part and yellowish brown, firm loam in the lower part. The substratum to a depth of about 60 inches is yellowish brown loam.

Permeability of this soil is moderate, and surface runoff is rapid. The available water capacity is high. The surface layer is slightly acid or medium acid, unless the soil has been limed in the past few years. The content of organic matter in the plow layer is 1 to 2 percent. The subsoil is medium in available phosphorus and very low in available potassium. This soil has good tilth.

Areas of this soil are used for corn, hay, and pasture. This soil is poorly suited to cultivated crops but is well suited to hay, pasture, and trees. It is poorly suited to sanitary facilities and building site development.

This soil is best suited to trees or grasses and legumes. It is poorly suited to cultivated crops. If the soil is cultivated, soil erosion is a severe hazard. To control erosion, this soil needs to be tilled on the contour and stripcropped with half of the area in meadow. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, increases water infiltration and helps to control runoff. Grassed waterways are needed to prevent the formation of gullies. Slopes are too steep for terracing. The return of all crop residue helps to maintain tilth.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees. Small areas remain in native hardwoods. Careful consideration should be given to the location of trails or roads used in logging on this soil in order to reduce the possibility of erosion. Laying out the trails or roads on the contour or nearly on the contour helps to reduce soil erosion. The slope of this soil is steep; therefore, some hazard is involved in the operation of equipment. Special equipment can be used, and caution should be exercised in its operation. Survival of seedlings or competition from undesirable plants should not be a problem.

This Lester soil is in capability subclass IVe.

236F—Lester loam, 18 to 25 percent slopes. This steep, well drained soil is on convex upland side slopes. Typically, these slopes are short. Individual areas are irregular in shape and range from 10 to 60 acres.

Typically, the surface layer is very dark gray loam about 5 inches thick. The subsurface layer is dark grayish brown loam about 4 inches thick. The subsoil is firm clay loam about 33 inches thick. The upper part is brown, the middle part is dark yellowish brown, and the lower part is yellowish brown. The substratum to a depth of about 60 inches is yellowish brown loam.

Permeability of this soil is moderate, and surface runoff is rapid. The available water capacity is high. The surface layer is slightly acid or medium acid, unless the soil has been limed in the past few years. The content of organic matter in the surface layer is about 1.5 to 2 percent. The subsoil is medium in available phosphorus and very low in available potassium. This soil has good tilth.

Most areas of this soil are in permanent pasture. This soil is generally unsuitable for cultivated crops but is moderately suited to trees. This soil is poorly suited to sanitary facilities and building site development.

This soil is better suited to grasses and legumes than other uses. Because of slope, low productivity, and the severe hazard of erosion, this soil is not suited to cultivation. Soil loss can be reduced significantly if a good vegetative cover is maintained.

If used for pasture, overgrazing or grazing when the soil is wet causes surface compaction and decreased water infiltration. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is moderately suited to trees. Small areas remain in native hardwoods. Careful consideration should be given to the location of trails or roads used in logging on this soil in order to reduce the possibility of erosion. Laying out the trails or roads on the contour or nearly on the contour helps to reduce soil erosion. The slope of this soil is steep; therefore, some hazard is involved in the operation of equipment. Special equipment can be used, and caution should be exercised in its operation. Survival of seedlings or competition from undesirable plants should not be a problem.

This Lester soil is in capability subclass VIe.

323C—Terril loam, sandy substratum, 5 to 9 percent slopes. This moderately sloping, moderately

well drained soil is on nearly plane to slightly concave foot slopes. Individual areas are long and narrow and range from 5 to 10 acres.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is loam about 23 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The subsoil, about 20 inches thick, is dark brown, friable loam in the upper part and brown, very friable sandy loam in the lower part. The substratum to a depth of about 60 inches is brown sand. In places, the subsoil is dark grayish brown loam.

Permeability of this soil is moderate, and surface runoff is medium. The available water capacity is high. The surface layer is neutral or slightly acid. The content of organic matter in the surface layer is about 4 to 5 percent. The subsoil is very low in available phosphorus and very low to low in available potassium. This soil has good tilth.

Most areas of this soil are cultivated. This soil is moderately suited to cultivated crops and well suited to grasses and legumes for hay and pasture. This soil is well suited to septic tank filter fields and moderately suited to building site development.

This soil is moderately suited to corn and soybeans. In places, diversion terraces can be used to protect this soil from runoff from adjacent uplands. If this soil is cultivated, erosion is a hazard. Soil loss can be reduced significantly by using conservation tillage, a practice that leaves crop residue on the surface throughout the year; contour farming; terraces; crop rotation; stripcropping; or a combination of these. Returning crop residue helps to maintain good tilth and increases water infiltration.

If used for pasture or hay, overgrazing or grazing when the soil is wet causes surface compaction and increased runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Terril soil is in capability subclass IIIe.

377C—Dinsdale silty clay loam, 5 to 9 percent slopes. This moderately sloping, well drained and moderately well drained soil is on convex nose slopes and side slopes on uplands. Individual areas are irregular in shape and 4 to 15 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is silty clay loam about 10 inches thick. It is very dark brown in the upper part and dark brown in the lower part. The subsoil is about 38 inches thick. It is brown, friable silty clay loam in the upper part; dark yellowish brown, firm loam in the middle part; and yellowish brown, firm loam in the lower part. The substratum to a depth of about 60 inches is yellowish brown loam. In places, the silty material is more than 42 inches thick.

Included with this soil in mapping are small areas of Liscomb soils. Liscomb soils formed in loamy till and are on the more sloping nose slopes. They make up about 5 percent of the map unit.

Permeability of this Dinsdale soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter in the surface layer is about 2.5 to 3.5 percent. The surface layer is medium acid, unless the soil has been limed in the past few years. The subsoil is medium acid, low in available phosphorus, and very low in available potassium. This soil has fair tilth.

Most areas of this soil are cultivated. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is well suited to septic tank filter fields and moderately suited to building site development.

This soil is moderately suited to corn and soybeans in rotation with oats and hay. To help control erosion in cultivated fields, this soil needs to be tilled on the contour, stripcropped, or terraced. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, also increases water infiltration and reduces erosion. Grassed waterways are needed to prevent the formation of gullies. In many places, terrace drop inlets can be constructed.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Dinsdale soil is in capability subclass IIIe.

377C2—Dinsdale silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained and moderately well drained soil is on convex upland side slopes. Individual areas are irregular in shape and 4 to 20 acres.

Typically, the surface layer is mixed very dark grayish brown and brown silty clay loam about 7 inches thick. The subsoil is about 35 inches thick. It is brown, friable silty clay loam in the upper part; dark yellowish brown, friable loam in the middle part and yellowish brown, mottled, firm loam in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled loam. Some places have silty material more than 42 inches thick. In places, the surface layer is brown silty clay loam.

Included with this soil in mapping are small areas of Liscomb soils. Liscomb soils formed in loamy till and are on the more sloping nose slopes. They make up about 5 percent of this map unit.

Permeability of this Dinsdale soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter in the surface layer is about 2 to 2.5 percent. The surface layer is medium acid, unless the soil has been limed in the past few years. The subsoil is medium acid, low in available phosphorus, and very low in available potassium. This soil has fair tilth.

Most areas of this soil are cultivated. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is well suited to septic tank filter fields and moderately suited to building site development.

This soil is moderately suited to corn and soybeans in rotation with oats and hay. To help control erosion in cultivated fields, this soil needs to be tilled on the contour, stripcropped, or terraced. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, also increases water infiltration and reduces erosion. Grassed waterways are needed to prevent the formation of gullies. In many places, terrace drop inlets can be constructed.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Dinsdale soil is in capability subclass IIIe.

377D2—Dinsdale silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained and moderately well drained soil is on convex upland side slopes. Individual areas are irregular in shape and are 4 to 15 acres.

Typically, the surface layer is mixed very dark grayish brown and brown silty clay loam about 7 inches thick. The subsoil is about 32 inches thick. It is brown, friable silty clay loam in the upper part; yellowish brown, mottled, friable silty clay loam in the middle part; and yellowish brown, mottled, firm loam in the lower part. The substratum to a depth of about 60 inches is mottled, yellowish brown loam. In places, the surface layer is brown silty clay loam. In places, the loess is more than 42 inches thick.

Included with this soil in mapping are small areas of Liscomb soils that formed in loamy till. Also included are areas of fine sandy loam and loamy fine sand. The sandy areas are high on the side slope, have less available water capacity, and are subject to severe erosion by wind. The inclusions make up 5 to 10 percent of this map unit.

Permeability of this Dinsdale soil is moderate, and surface runoff is rapid. The available water capacity is high. The content of organic matter in the surface layer is 1.5 to 2 percent. The surface layer is medium acid, unless the soil has been limed in the past few years. The subsoil is medium acid, low in available phosphorus, and very low in available potassium. This soil has fair tilth.

Most areas of this soil are cultivated. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is well suited to septic tank filter fields and moderately suited to building site development.

This soil is moderately suited to corn and soybeans if they are used in rotation with oats and hay. To help control erosion in cultivated fields, this soil needs to be tilled on the contour, stripcropped, or terraced. Row crops can be included in the cropping system more often if soils are terraced and tilled on the contour. Grassed waterways are needed to prevent the formation of gullies. In many places, terrace drop inlets can be constructed. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, increases water infiltration and reduces the hazard of erosion.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Dinsdale soil is in capability subclass IIIe.

420B—Tama silty clay loam, benches, 2 to 5 percent slopes. This gently sloping, well drained soil is on benches adjacent to major streams. Typical areas are irregular and broad in shape and range from 10 to 100 acres.

Typically, the surface layer is very dark brown silty clay loam about 7 inches thick. The subsurface layer is silty clay loam about 9 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The subsoil is about 28 inches thick. It is brown, friable silty clay loam in the upper part and yellowish brown friable silty clay loam in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled silty clay loam. Texture of the substratum varies because of stratified sands and silty materials that underlie this soil within a depth of 8 feet. Small areas that have thicker surface and subsurface layers are sometimes adjacent to the waterways that dissect this map unit.

Included with this soil in mapping are small areas of Colo soils along the waterways that dissect this map unit. Colo soils are poorly drained and require artificial drainage. They make up 5 to 10 percent of this map unit.

Permeability of this Tama soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter in the surface layer is 3 to 4 percent. The surface layer is neutral or slightly acid. The subsoil is medium acid or slightly acid, medium in available phosphorus, and very low in available potassium. This soil has fair tilth.

Areas of this soil are mostly cultivated and used intensively for row crops. This soil is well suited to cultivated crops, hay, and pasture. It is moderately suited to sanitary facilities and building site development.

This soil is well suited to corn and soybeans if they are used in rotation with small grain and hay. Where row crops are grown often in the rotation, tilling on the contour, stripcropping or terracing, and conservation tillage, a practice that leaves crop residue on the surface

throughout the year, are needed to help reduce soil loss. This soil responds well to a high level of management. Runoff can be controlled by diversions located at foot slope positions.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Tama soil is in capability subclass IIe.

420C2—Tama silty clay loam, benches, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on benches adjacent to the major streams. Individual areas are irregular in shape and range from 5 to more than 60 acres.

Typically, the surface layer, about 7 inches thick, is very dark brown silty clay loam with some mixing of dark brown and brown former subsoil material. The subsoil is friable silty clay loam about 25 inches thick. It is brown in the upper part and yellowish brown with grayish brown mottles in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled, silty clay loam. Small areas that have thicker surface and subsurface layers are sometimes along the waterways that dissect this map unit. Texture of the substratum varies because of stratified sands and silty materials that underlie this soil within a depth of 8 feet.

Included with this soil in mapping are small areas of Colo soils along the waterways that dissect this map unit. Colo soils are poorly drained and require artificial drainage. They make up 5 to 10 percent of this map unit.

Permeability of this Tama soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter in the surface layer is 2.5 to 3.5 percent. The surface layer is neutral or slightly acid. The subsoil is medium acid or slightly acid. The subsoil is medium in available phosphorus and very low in available potassium. This soil has fair tilth.

Areas of this soil are mostly cultivated and used intensively for row crops. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is moderately suited to septic tank filter fields and building site development.

This soil is moderately suited to corn and soybeans if they are used in the rotation system about one-half of the time. To help control erosion in cultivated fields, this soil needs conservation tillage, a practice that leaves crop residue on the surface throughout the year, along with contouring, stripcropping, or terracing. Conservation tillage also increases water infiltration and reduces the hazard of erosion. Grassed waterways are needed to prevent the formation of gullies. In many places, drop inlets need to be constructed. Runoff from adjacent slopes can be controlled by diversions at the foot slope position.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Tama soil is in capability subclass IIIe.

428B—Ely silty clay loam, 2 to 5 percent slopes. This gently sloping, somewhat poorly drained soil is on slightly concave, low foot slopes and alluvial fans. Individual areas on foot slopes are long and narrow and range from 3 to 15 acres. Areas on the alluvial fans range from 5 to 10 acres.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is silty clay loam about 17 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil is friable silty clay loam about 34 inches thick. It is dark grayish brown in the upper part and grayish brown, light brownish gray, and mottled in the lower part. In places, the subsoil is dark brown in the upper part.

Included with this soil in mapping are small areas of Colo soils. The Colo soils are poorly drained and are adjacent to waterways that dissect the Ely unit. They make up 5 to 10 percent of this map unit.

Permeability of this Ely soil is moderate, and surface runoff is medium. The available water capacity is very high. This soil has a seasonal high water table. The content of organic matter in the surface layer is 4 to 6 percent. The surface layer and the subsoil are slightly acid or neutral. The subsoil is very low in available phosphorus and available potassium. This soil has fair tilth.

Most areas of this soil are in cropland, but some areas are in pasture. This soil is well suited to cultivated crops, hay, and pasture. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. Individual areas are generally small and in most places are cropped with adjacent soils. Some areas receive runoff from side slopes. This causes siltation or erosion, and in places runoff water concentrates and causes gullying. Other areas are subject to short duration flooding from small streams.

The use of this soil for pasture or hay effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition. Diversions help to protect the soil from overflow and siltation.

This Ely soil is in capability subclass IIw.

430—Ackmore silt loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained or poorly drained

soil is on alluvial fans or flood plains. Areas of this soil are subject to frequent flooding. Individual areas are long and moderately wide and are 10 to 60 acres.

Typically, the surface layer is very dark gray and very dark grayish brown silt loam about 7 inches thick. The underlying substratum to a depth of about 27 inches is stratified, very dark gray, very dark grayish brown, and dark grayish brown silt loam (fig. 15). Below the substratum to a depth of about 60 inches is a black, silty clay loam, buried soil. In the northeastern part of the county, the surface layer and substratum are darker and do not have significant stratification.

Included with this soil in mapping are small areas of poorly drained Colo soils. The Colo soils are on lower parts of the bottom lands that have not received recent deposits of silty sediment. They make up 5 to 10 percent of this map unit.

Permeability of this Ackmore soil is moderate, and runoff is slow. The available water capacity is very high. This soil has a seasonal high water table. The content of organic matter in the surface layer is about 1 to 3 percent. Typically, the soil is medium acid to neutral. The substratum is generally low in available phosphorus and very low in available potassium. Typically, the surface layer has good tilth.

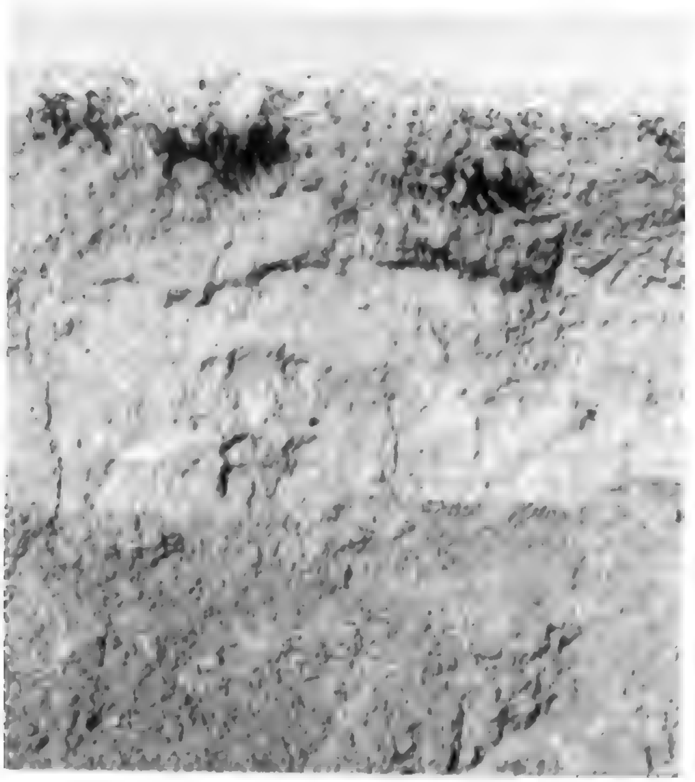


Figure 15.—Profile of Ackmore silt loam, 0 to 2 percent slopes, showing stratified, light colored overwash over a dark buried soil.

Most areas of this soil are cultivated. This soil is well suited to cultivated crops, hay, and pasture. It is poorly suited to trees. This soil is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn, soybeans, small grains, and grasses and legumes for hay and pasture. Most areas of this soil are suited to intensive row cropping if adequately protected from flooding. Most flooding occurs before corn is planted. Levees and dikes can provide flood protection.

This soil is poorly suited to trees because it has a seasonal high water table and is subject to flooding. Trees that tolerate wet conditions should be selected.

This Ackmore soil is in capability subclass IIw.

442B—Dickinson-Sparta-Tama complex, 2 to 5 percent slopes. This map unit consists of gently sloping, well drained, somewhat excessively drained, and excessively drained soils on convex upland summits near major streams. Individual areas are elliptical and range from 5 to 100 acres.

Individual areas are about 60 percent Dickinson soils, 20 percent Sparta soils, and 10 to 15 percent Tama soils. The Dickinson soil is on plane or slightly convex areas and on the broader ridgetops. The Sparta soil is on the narrow ridgetops that are generally higher than the surrounding landscape. The Tama soil is on the lower parts of the side slopes.

Typically, the Dickinson soil has a surface layer of black fine sandy loam about 5 inches thick. The subsurface layer is fine sandy loam about 13 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil, about 35 inches thick, is dark brown, friable fine sandy loam in the upper part; brown and dark yellowish brown, friable fine sandy loam in the middle part; and yellowish brown, friable loamy sand in the lower part. The substratum to a depth of about 60 inches is brown loamy sand. In places, the surface layer is high in clay content, and the subsoil has dark grayish brown colors. In places, the subsoil and substratum are silty clay loam.

Typically, the Sparta soil has a surface layer of very dark brown loamy fine sand about 7 inches thick. The subsurface layer is very dark grayish brown loamy fine sand about 12 inches thick. The subsoil is dark yellowish brown, very friable loamy fine sand about 13 inches thick. The substratum to a depth of about 60 inches is yellowish brown sand. In places, combined thickness of the surface layer and subsurface layer is less than 10 inches.

Typically, the Tama soil has a surface layer of very dark brown silty clay loam about 7 inches thick. The subsurface layer is silty clay loam about 9 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The subsoil is friable silty clay loam about 28 inches thick. It is brown in the upper part, yellowish brown in the middle part, and dark yellowish brown in the lower part. The substratum to a

depth of about 60 inches is brown and grayish brown silty clay loam that has grayish brown mottles. In some areas near the heads of drainageways, mottling is at a depth as shallow as 20 inches.

Included in this complex are small areas of somewhat poorly drained Muscatine soils. Muscatine soils are on nearly level areas and on foot slopes. They make up 5 to 10 percent of the map unit.

Permeability of the Dickinson soil is moderately rapid in the upper part and rapid in the lower part. The Sparta soil is rapidly permeable, and the Tama soil is moderately permeable. Runoff is medium. The available water capacity is moderate for the Dickinson soil, slow for the Sparta soil, and high for the Tama soil. The content of organic matter in the surface layer is about 1 to 2 percent in the Dickinson soil, 1 to 1.5 percent in the Sparta soil, and 3 to 4 percent in the Tama soil. The subsoil of the Dickinson soil is medium acid or strongly acid. The subsoil of the Sparta and Tama soils is slightly acid to strongly acid. The available phosphorus in the subsoil is very low for the Dickinson and Sparta soils and medium for the Tama soils. The available potassium is very low in all three soils. The Dickinson and Sparta soils have good tilth. The Tama soil has fair tilth.

Areas of these soils are used mainly for hay, pasture, and woodland. Some areas are in cultivated crops. These soils are poorly suited to cultivated crops and moderately suited to hay, pasture, and trees. These soils are poorly suited to sanitary facilities and well suited to building site development.

The soils of this complex are poorly suited to cultivated crops. The soils have low natural fertility and are difficult to vegetate. Erosion by wind is a major hazard. Stripcropping and conservation tillage, a practice that leaves crop residue on the surface throughout the year, are needed to reduce soil loss. A good cover crop and grassed waterways help to prevent the formation of blowouts and gullies.

These soils are moderately suited to trees, but most areas of trees are limited to groves around farmsteads. Natural and planted seedlings do not survive well, but seedlings can be spaced closer together. The surviving trees can be thinned later to achieve the desired stand density. Competing vegetation needs to be controlled by site preparation or by spraying or cutting. There are no other hazards for planting or harvesting trees.

The soils in this complex are in capability subclass IVs.

442C2—Dickinson-Sparta-Tama complex, 5 to 12 percent slopes, moderately eroded. This map unit consists of moderately sloping and strongly sloping, well drained, somewhat excessively drained, and excessively drained soils on convex upland summits near major streams. Individual areas are elliptical and range from 5 to 160 acres.

Individual areas are about 40 percent Dickinson soils, 35 percent Sparta soils, and 20 percent Tama soils. The Dickinson soil is on the less sloping areas and broader ridgetops. The Sparta soil is on narrow ridgetops and hummocks that are higher than the surrounding landscape. The Tama soil is on the lower parts of the side slopes.

Typically, the Dickinson soil has a surface layer, about 7 inches thick, of very dark grayish brown fine sandy loam with some mixing of dark brown and brown former subsoil material. The subsoil, about 35 inches thick, is brown and dark yellowish brown, friable fine sandy loam in the upper part and yellowish brown, friable loamy sand in the lower part. The substratum is brown loamy sand to a depth of about 60 inches. In places, the surface layer is thinner and is dark grayish brown. Some areas have a surface layer about 13 inches thick.

Typically, the Sparta soil has a surface layer of very dark brown loamy fine sand about 7 inches thick. The subsurface layer is very dark grayish brown loamy fine sand about 12 inches thick. The subsoil is dark yellowish brown, very friable loamy fine sand about 12 inches thick. The substratum to a depth of about 60 inches is yellowish brown sand. In places, the combined thickness of the surface layer and subsurface layer is less than 10 inches.

Typically, the Tama soil has a surface layer, about 6 inches thick, of very dark grayish brown silty clay loam with some mixing of dark brown and brown former subsoil material. The subsoil is friable silty clay loam about 26 inches thick. It is brown in the upper part and yellowish brown with a few grayish brown mottles in the lower part. The substratum to a depth of about 60 inches is yellowish brown silty clay loam with a few light brownish gray mottles. In some cove positions, this soil has gray mottles in the upper part of the subsoil and a light brownish gray substratum. Some areas have a surface layer about 11 inches thick. In places, the surface layer is calcareous.

Included in this complex are small areas of somewhat poorly drained Muscatine soils. Muscatine soils are on nearly level areas and on foot slopes. They make up 5 to 10 percent of the map unit.

Permeability of the Dickinson soil is moderately rapid in the upper part and rapid in the lower part. The Sparta soil is rapidly permeable and the Tama soil is moderately permeable. The available water capacity is moderate for the Dickinson soil, low for the Sparta soil, and high for the Tama soil. Surface runoff is medium. The content of organic matter in the surface layer is less than 1 percent for the Dickinson and Sparta soils and 2.5 to 3 percent for Tama soil. The subsoil of all three soils is slightly acid to strongly acid. The available phosphorus in the subsoil is very low in the Dickinson and Sparta soils and medium in the Tama soil. The available potassium in the subsoil is very low in all three soils. The Dickinson and Sparta soils have good tilth. The Tama soil has fair tilth.

Areas of these soils are used mainly for hay, pasture, and woodland. Some areas are in cultivated crops. These soils are poorly suited to cultivated corps and moderately suited to hay, pasture, and trees. They are

poorly suited to sanitary facilities and moderately suited to building site development.

The soils in this complex are poorly suited to corn and soybeans. They are better suited to hay and pasture. These soils have low natural fertility and are difficult to vegetate. Erosion by wind is a severe hazard. Stripcropping and conservation tillage, a practice that leaves crop residue on the surface throughout the year, are needed to reduce soil loss. A good cover crop and grassed waterways help to prevent the formation of blowouts and gullies.

These soils are moderately suited to trees, but most areas of trees are limited to groves around farmsteads. Natural and planted seedlings do not survive well, but seedlings can be spaced closer together. The surviving trees can be thinned later to achieve the desired stand density. Competing vegetation needs to be controlled by site preparation or by spraying or cutting.

The soils in this complex are in capability subclass IVs.

442E2—Dickinson-Sparta-Tama complex, 12 to 18 percent slopes, moderately eroded. This map unit consists of strongly sloping and moderately steep, well drained, somewhat excessively drained, and excessively drained soils on convex slopes of uplands near major streams. Individual areas are irregular in shape and range from 5 to 100 acres.

Individual areas are about 45 to 55 percent Dickinson soil, 30 percent Sparta soil, and 15 percent Tama soil. The Dickinson soil is on the less sloping areas. The Sparta soil is on narrow ridgetops and hummocks that are higher than the surrounding landscape. The Tama soil is on the lower parts of the side slopes.

Typically, the Dickinson soil has a surface layer, about 7 inches thick, of very dark grayish brown fine sandy loam with some mixing of dark brown and brown former subsoil material. The subsoil, about 35 inches thick, is brown and dark yellowish brown, friable fine sandy loam in the upper part and yellowish brown, friable loamy sand in the lower part. The substratum is brown loamy sand to a depth of about 60 inches. In places, the surface layer is thinner and dark grayish brown. Some areas have a surface layer about 13 inches thick.

Typically, the Sparta soil has a surface layer of very dark grayish brown loamy fine sand about 6 inches thick. The subsurface layer is dark brown loamy fine sand about 10 inches thick. The subsoil is dark yellowish brown, very friable loamy fine sand about 12 inches thick. The substratum to a depth of about 60 inches is yellowish brown sand. In places, the combined thickness of the surface layer and subsurface layer is less than 10 inches.

Typically, the Tama soil has a surface layer of very dark grayish brown silty clay loam about 5 inches thick. The subsoil is friable silty clay loam about 24 inches thick. It is brown in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown silty clay loam that has grayish brown mottles. In some cove positions, this soil has gray mottles in the upper part of the subsoil and a light brownish gray substratum. In some areas, the surface layer is calcareous.

Permeability of the Dickinson soil is moderately rapid in the upper part and rapid in the lower part. The Sparta soil is rapidly permeable, and the Tama soil is moderately permeable. The available water capacity is moderate for the Dickinson and Sparta soils and high for the Tama soil. Surface runoff is medium. The content of organic matter is less than 0.5 percent in the surface layer of the Dickinson and Sparta soils and about 2 to 3 percent in the surface layer of the Tama soil. The subsoil of all three soils is slightly acid to strongly acid. The available phosphorus in the subsoil is very low in the Dickinson and Sparta soils and medium in the Tama soil. The available potassium is very low in all three soils. The Dickinson and Sparta soils have good tilth. The Tama soil has fair tilth.

Areas of these soils are used mainly for hay, pasture, woodland, and some cultivated crops. These soils are generally unsuitable for cultivated crops. They are moderately suited to hay, pasture, and trees. They are poorly suited to sanitary facilities and moderately suited to building site development.

The soils in this complex are generally unsuited to cultivated crops. These soils have low natural fertility and are difficult to vegetate. Erosion by wind and water is a severe hazard. A good cover crop and grassed waterways help to prevent the formation of blowouts and gullies.

These soils are moderately suited to trees, but most areas of trees are limited to groves around farmsteads. Natural and planted seedlings do not survive well, but seedlings can be spaced closer together. The surviving trees can be thinned later to achieve the desired stand density. Competing vegetation needs to be controlled by site preparation or by spraying or cutting. There are no other hazards for planting or harvesting trees.

The soils in this complex are in capability subclass VIs.

462B—Downs silt loam, benches, 2 to 5 percent slopes. This gently sloping, well drained soil is on benches adjacent to major streams. Individual areas are irregular in shape and range from 10 to more than 40 acres.

Typically, the surface layer is very dark grayish brown and very dark brown silt loam about 7 inches thick. The subsurface layer is very dark grayish brown silt loam about 5 inches thick. The subsoil is friable silty clay loam about 35 inches thick. It is brown in the upper part and brown and yellowish brown with a few grayish mottles in the lower part. The substratum to a depth of about 60 inches is brown, light brownish gray, and strong brown, mottled silty clay loam. The texture of the substratum within a depth of 5 to 8 feet varies because of stratified sands and silty material that underlies this soil. In places, the surface layer is thinner.

Permeability of this soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter in the surface layer is 2 to 3 percent. The surface layer is medium acid, unless the soil has been limed in the past few years. The subsoil is medium acid or strongly acid, medium in available phosphorus, and very low in available potassium. This soil has good tilth.

Areas of this soil are used for cultivated crops, trees, hay, and pasture. This soil is well suited to these uses. It is moderately suited to septic tank filter fields and building site development.

This soil is well suited to corn and soybeans if they are used in rotation with small grain and hay. Where row crops are grown often in the rotation, tilling on the contour, stripcropping or terracing, and conservation tillage, a practice that leaves crop residue on the surface throughout the year, are needed to help reduce soil loss. Runoff can be controlled by the use of diversions located at the foot slope position.

This soil is well suited to trees. A few small areas remain in native hardwoods. Natural and planted seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by careful site preparation or by spraying, cutting, or girdling. There are no hazards or limitations for planting or harvesting trees.

This Downs soil is in capability subclass IIe.

484—Lawson silty clay loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on first and second bottoms near the Iowa River. Areas of this soil are subject to occasional flooding. Individual areas range from 5 to 120 acres and are broad and slightly irregular in shape.

Typically, the surface layer is black silty clay loam about 6 inches thick. The subsurface layer is silty clay loam about 24 inches thick. It is black and very dark brown in the upper part and very dark grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled silty clay loam. In places, the combined thickness of the surface layer and subsurface layer is more than 36 inches. In places, the soil has been drastically altered. Some areas have been cut, built up, or smoothed during construction.

Included with this soil in mapping are small areas of somewhat poorly drained Lawler soils and poorly drained Zook soils. Lawler soils are loamy and are on the higher areas on the second bottoms. Zook soils are on the lower parts of the first bottoms. The inclusions make up 5 to 10 percent of this map unit.

Permeability of this Lawson soil is moderate, and surface runoff is slow. The available water capacity is very high. This soil has a seasonal high water table. The content of organic matter in the surface layer is 4.5 to 6 percent. The surface layer and subsoil are neutral or slightly acid. The subsoil is low in available phosphorus and very low in available potassium. This soil has fair tilth.

Most areas of this soil are cultivated. This soil is well suited to cultivated crops, hay, and pasture but is poorly suited to trees. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. Most areas of this soil are suited to intensive row cropping if adequately protected from flooding. Most flooding occurs before corn is planted. Levees and dikes can provide flood protection. Tile drains function well if adequate outlets are available.

This Lawson soil is in capability subclass IIw.

485—Spillville loam, 0 to 2 percent slopes. This nearly level, moderately well drained and somewhat poorly drained soil is on first bottom lands adjacent to major streams and tributaries in the western part of the county. Areas of this soil are subject to occasional flooding. Individual areas are long and moderately wide and are 10 to 200 acres. In areas where the stream channel has been straightened, Spillville soils are along old channels.

Typically, the surface soil is black loam about 40 inches thick. The substratum is very dark grayish brown and very dark gray loam to a depth of about 60 inches. In places, small areas of soils are higher in silt and lower in sand. In places, the substratum is sandy loam.

Included with this soil in mapping are small areas of poorly drained Colo soils. Colo soils are in concave areas and are higher in content of clay. They make up about 10 percent of the map unit.

Permeability of this Spillville soil is moderate, and surface runoff is slow. This soil has a seasonal high water table. The available water capacity is high. The content of organic matter in the surface layer is 4 to 5 percent. The surface layer is neutral or slightly acid. The subsoil is low in available phosphorus and very low in available potassium. Tilth is good.

Most areas of this soil are cultivated. This soil is well suited to cultivated crops, hay, and pasture. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. Most areas of this soil are suited to intensive row cropping if adequately protected from flooding. Most flooding occurs before corn is planted. Levees and dikes can provide flood protection. Tile drains function well if adequate outlets are available.

This Spillville soil is in capability subclass IIw.

507—Canisteo silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is in swales on uplands. Individual areas are irregular in shape and generally are 10 to 100 acres.

Typically, the surface layer is black, calcareous silty clay loam about 6 inches thick. The subsurface layer is black and very dark gray, calcareous clay loam about 13 inches thick. The subsoil is calcareous, friable clay loam

about 21 inches thick. It is dark gray in the upper part, gray and olive gray in the middle part, and olive gray and light olive gray in the lower part. The substratum to a depth of about 60 inches is light gray, calcareous loam that has strong brown mottles. Some areas do not have lime in the upper 10 inches.

Included with this soil in mapping are a few areas of Okoboji soils in depressions that are subject to ponding. These soils make up 5 to 10 percent of the map unit.

Permeability of this Canisteo soil is moderate, and surface runoff is slow to ponded. This soil has a seasonal high water table. Some slightly depressed areas tend to pond during periods of heavy rainfall. The available water capacity is high. The surface layer is moderately alkaline. The soil is calcareous throughout. The content of organic matter in the plow layer is 6 to 7 percent. The subsoil is very low in available phosphorus and available potassium. The surface layer has fair tilth.

Most areas of this soil are cultivated. This soil is well suited to cultivated crops and grasses and legumes for hay and pasture if artificially drained. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn and soybeans. It is slow to warm in the spring and tends to dry out and become cloddy and hard if worked when wet. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, helps to prevent excessive soil loss from wind erosion. Returning crop residue helps to maintain good tilth and increases water infiltration. The high lime content restricts the availability of phosphorus, potassium, and other micronutrients.

If used for pasture, overgrazing or grazing when the soil is wet causes surface compaction and decreased infiltration. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This Canisteo soil is in capability subclass IIw.

536—Hanlon fine sandy loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on first bottoms adjacent to the Iowa River. Areas of this soil are subject to frequent flooding. Individual areas are long and moderately wide and are 10 to 160 acres.

Typically, the surface layer is very dark gray fine sandy loam about 8 inches thick. The subsurface layer is very dark grayish brown fine sandy loam about 23 inches thick. The subsoil is very dark grayish brown, friable fine sandy loam about 9 inches thick. The substratum to a depth of about 60 inches is stratified, very dark grayish brown, dark grayish brown, and grayish brown fine sandy loam and loamy fine sand.

Included with this soil in mapping are small areas of excessively drained stratified sands. These areas are droughty when cropped. They make up 5 to 10 percent of this map unit.

Permeability of this Hanlon soil is moderately rapid, and surface runoff is slow. The available water capacity is moderate. This soil has a seasonal high water table. The content of organic matter in the surface layer is 2 to 4 percent. The surface layer is slightly acid or neutral, and the subsoil is neutral. The subsoil is very low in available phosphorus and available potassium. This soil has good tilth.

Most areas of this soil are cultivated. This soil is well suited to cultivated crops, hay, pasture, and trees. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. Most areas of this soil are suited to intensive row cropping if adequately protected from flooding. Most flooding occurs before corn is planted. Levees and dikes can provide flood protection. Tile drains function well if adequate outlets are available.

This soil is well suited to trees. A few small areas remain in native hardwoods. Natural and planted seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by careful site preparation or by spraying, cutting, or girdling. There are no hazards or limitations for planting or harvesting trees.

This Hanlon soil is in capability subclass IIw.

595—Harpster silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is in slightly concave positions on wide upland divides and at heads of upland drains. Areas of this soil are subject to ponding. Individual areas are irregular in shape and range from 3 to 50 acres.

Typically, the surface layer is black, calcareous silty clay loam about 8 inches thick. The subsurface layer is calcareous silty clay loam about 12 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is calcareous, friable silty clay loam about 22 inches thick. It is very dark gray and dark gray in the upper part and mottled and olive gray in the lower part. The substratum to a depth of about 60 inches is mottled, light gray, calcareous silt loam. In some areas, the surface layer and subsurface layer are not calcareous.

Permeability of this soil is moderate, and surface runoff is slow to ponded. The available water capacity is high. This soil has a seasonal high water table. The content of organic matter in the surface layer is about 5 to 6 percent. The surface layer and the subsoil are mildly alkaline. The available phosphorus and available potassium in the soil are very low. This soil has fair tilth.

Areas of this soil are cultivated and used intensively for row crops. This soil is well suited to cultivated crops, hay, and pasture. It is generally unsuitable for sanitary facilities and building site development.

This soil is well suited to row crops, oats, hay, and pasture if drainage is adequate. Tile drains this soil satisfactorily. Small areas are subject to ponding. Shallow ditches can remove excess surface water. Restricted drainage delays field operations in some years. This soil has excess lime.

This Harpster soil is in capability subclass IIw.

683C2—Liscomb loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained and moderately well drained soil is on upland nose slopes. Individual areas are 4 to 20 acres and are irregular in shape.

Typically, the surface layer is mixed very dark grayish brown and dark brown loam about 8 inches thick. The subsoil is friable loam about 36 inches thick. It is dark yellowish brown in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is brown and yellowish brown loam.

Included with this soil in mapping are small areas of Dinsdale soils. Dinsdale soils formed in loess overlying glacial till and often occur in an intermingled pattern with Liscomb soil on nose slopes and side slopes. Dinsdale soils make up 5 to 10 percent of this map unit.

Permeability of this Liscomb soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter in the surface layer is 2 to 3 percent. The surface layer is neutral. The subsoil is medium acid or slightly acid, and is very low in available phosphorus and available potassium. This soil has good tilth.

Most areas of this soil are cultivated. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is well suited to septic tank filter fields and building site development.

This soil is moderately suited to corn and soybeans if they are used in rotation with oats and hay. To help control erosion in cultivated fields, this soil needs to be tilled on the contour, stripcropped, or terraced. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, also increases water infiltration and reduces erosion. Grassed waterways are needed to prevent the formation of gullies. In many places, terrace drop inlets can be constructed.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotations, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Liscomb soil is in capability subclass IIIe.

683D—Liscomb loam, 9 to 14 percent slopes. This strongly sloping, well drained and moderately well drained soil is on short, convex upland nose slopes and side slopes. Individual areas are 4 to 40 acres and are elongated.

Typically, the surface layer is very dark brown loam about 5 inches thick. The subsurface layer is very dark grayish brown loam about 7 inches thick. The subsoil is friable loam about 30 inches thick. It is dark brown and dark yellowish brown in the upper part and dark yellowish brown and yellowish brown in the lower part. The substratum to a depth of about 60 inches is grayish brown and yellowish brown loam.

Included with this soil in mapping are small areas of Dinsdale soils and a few sandy spots. Dinsdale soils are in an intermingled pattern with the Liscomb soil and formed in loess over glacial till. The sandy spots have lower content of organic matter and lower natural fertility than this Liscomb soil. They are on similar landscapes. The inclusions make up 5 to 10 percent of this map unit.

Permeability of this Liscomb soil is moderate, and surface runoff is rapid. The available water capacity is high. The content of organic matter in the surface layer is about 2 to 3 percent. The surface layer is neutral. The subsoil is medium acid or slightly acid, and is very low in available phosphorus and available potassium. This soil has good tilth.

Areas of this soil are used for cultivated crops, hay, and pasture. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is moderately suited to sanitary facilities and building site development.

This soil is moderately suited to corn and soybeans. If the soil is cultivated, soil erosion is a severe hazard. To control erosion, this soil needs to be tilled on the contour, stripcropped, or terraced. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, and terraces increase water infiltration and control runoff. Grassed waterways are needed to prevent the formation of gullies. In many places, terrace drop inlets can be constructed. The return of all crop residue helps to maintain tilth.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when this soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Liscomb soil is in capability subclass IIIe.

683D2—Liscomb loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained and moderately well drained soil is on short, convex nose slopes and side slopes on uplands. Individual areas are elongated and 4 to 60 acres.

Typically, the surface layer is mixed very dark grayish brown and dark brown loam about 7 inches thick. The subsoil, about 28 inches thick, is brown and dark yellowish brown, friable loam in the upper part and yellowish brown, friable clay loam in the lower part. The substratum to a depth of about 60 inches is brown and yellowish brown loam. In places, the surface layer is brown and dark yellowish brown loam.

Included with this soil in mapping are small areas of Dinsdale soils and sandy spots. Dinsdale soils are in an intermingled pattern with Liscomb soil and formed in loess over glacial till. The sandy spots have lower content of organic matter and lower natural fertility than

this Liscomb soil. The inclusions make up 5 to 10 percent of this map unit.

Permeability of this Liscomb soil is moderate, and surface runoff is rapid. The available water capacity is high. The content of organic matter in the surface layer is about 1 to 2 percent. The surface layer is neutral. The subsoil is medium acid or slightly acid, and is very low in available phosphorus and available potassium. This soil has good tilth.

Areas of this soil are used for cultivated crops, hay, and pasture (fig. 16). This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is poorly suited to sanitary facilities and building site development.

This soil is moderately suited to corn and soybeans. If the soil is cultivated, soil erosion is a hazard. To control erosion, this soil needs to be tilled on the contour, stripcropped, or terraced. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, and terraces increase water infiltration and control runoff. Grassed waterways are needed to prevent the formation of gullies. In many places, terrace drop inlets can be constructed. The return of all crop residue helps to maintain tilth.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when this soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Liscomb soil is in capability subclass IIIe.

683E—Liscomb loam, 14 to 18 percent slopes. This moderately steep, well drained and moderately well drained soil is on short, convex upland side slopes. Individual areas are elongated and 4 to 30 acres.

Typically, the surface layer is very dark brown and very dark grayish brown loam about 10 inches thick. The subsoil is friable loam about 30 inches thick. It is dark yellowish brown in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is brown and yellowish brown loam.

Figure 16.—Corn growing on Liscomb loam, 9 to 14 percent slopes, moderately eroded.

Included with this soil in mapping on convex knobs are small areas of sand. These areas have a lower content of organic matter and lower natural fertility than this Liscomb soil. They make up 5 percent of this map unit.

Permeability of this Liscomb soil is moderate, and surface runoff is rapid. The available water capacity is high. The content of organic matter in the surface layer is 2 to 3 percent. The surface layer is neutral. The subsoil is medium acid or slightly acid, and is very low in available phosphorus and available potassium. This soil has good tilth.

Areas of this soil are used for cultivated crops, hay, and pasture. This soil is poorly suited to cultivated crops but is well suited to hay and pasture. It is poorly suited to sanitary facilities and building site development.

This soil is better suited to grasses and legumes than to other crops. It is poorly suited to cultivated crops. If the soil is cultivated, soil erosion is a severe hazard. Conservation tillage and stripcropping with half of the area in meadow helps to control erosion. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, increases water infiltration and helps to control runoff. Grassed waterways are needed to prevent the formation of gullies. Slopes are too steep for terracing. The return of all crop residue helps to maintain tilth.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Liscomb soil is in capability subclass IVe.

683E2—Liscomb loam, 14 to 18 percent slopes, moderately eroded. This moderately steep, well drained and moderately well drained soil is on short, convex side slopes on uplands. Individual areas are 4 to 40 acres. They are in short, narrow bands that border drainageways.

Typically, the surface layer is mixed dark brown and brown loam about 6 inches thick. The subsoil is friable loam about 28 inches thick. It is brown and dark yellowish brown in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is brown and yellowish brown loam. In places, the surface layer is brown and dark yellowish brown loam.

Included with this soil in mapping on convex knobs are small sandy areas. The sandy areas have a lower content of organic matter and lower natural fertility than this Liscomb soil. They make up 5 percent of this map unit.

Permeability of this Liscomb soil is moderate, and surface runoff is rapid. The available water capacity is high. The content of organic matter in the surface layer is 1 to 2 percent. The surface layer is neutral. The subsoil is medium acid or slightly acid, and is very low in available phosphorus and available potassium. This soil has good tilth.

Areas of this soil are used for corn, hay, and pasture. This soil is poorly suited to cultivated crops but is well suited to hay and pasture. It is poorly suited to sanitary facilities and building site development.

This soil is better suited to grasses and legumes than other uses. It is poorly suited to corn and soybeans. If the soil is cultivated, soil erosion is a severe hazard. Conservation tillage and stripcropping with half the area in meadow helps to control erosion. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, increases water infiltration and helps to control runoff. Grassed waterways are needed to prevent the formation of gullies. Slopes are too steep for terracing. The return of all crop residue helps to maintain tilth.

The use of this soil for pasture or hay also effectively helps to control erosion. Overgrazing or grazing when the soil is wet causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Liscomb soil is in capability subclass IVe.

688—Koszta silt loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is on plane or slightly convex slopes of low stream benches or high second bottoms. Flooding is unlikely but possible under abnormal conditions. Flooding is rare and very brief. Individual areas range from 5 to 160 acres in a broad irregular pattern.

Typically, the surface layer is very dark gray and very dark grayish brown silt loam about 8 inches thick. The subsurface layer is dark grayish brown silt loam about 6 inches thick. The subsoil, about 36 inches thick, is brown, friable silty clay loam in the upper part and mottled, grayish brown and yellowish brown, firm silty clay loam in the lower part. The substratum to a depth of about 60 inches is mottled, light gray and yellowish brown silty clay loam.

Included with this soil in mapping are small areas of poorly drained Bremer soils and small depressions that are subject to ponding. Bremer soils are on lower areas of the map unit. The small depressions tend to pond for short periods and have a subsoil that is higher in clay content. These inclusions make up 5 to 10 percent of the map unit.

Permeability of this Koszta soil is moderate, and surface runoff is slow. The available water capacity is high. This soil has a seasonal high water table. The content of organic matter in the surface layer is 2 to 3 percent. The surface layer is slightly acid or medium acid, unless the soil has been limed in the past few years. The subsoil is medium acid or strongly acid, low in available phosphorus, and very low in available potassium. This soil has good tilth.

Areas of this soil are cultivated and used intensively for row crops. This soil is well suited to cultivated crops, hay, pasture, and trees. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. Individual areas that are small in size are cropped with adjacent soils in most places. This soil is slightly higher than the adjacent first bottom lands and generally is only rarely flooded. In places, areas adjacent to foot slopes receive runoff. Tile drainage is not normally needed but is beneficial in some areas. Diversions prevent runoff from adjacent side slopes.

This soil is well suited to hay and pasture in a cropping sequence with alfalfa as the main plant. Both warm and cool season grasses should be included in pasture rotation systems. Grasses and legumes increase water infiltration, protect the soil from wind erosion, and improve tilth. Overgrazing or grazing when the soil is wet causes surface compaction and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees. A few small areas remain in native hardwoods. Natural and planted seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by careful site preparation or by spraying, cutting, or girdling. There are no hazards or limitations for planting or harvesting trees.

This Koszta soil is in capability class I.

1133—Colo silty clay loam, channeled, 0 to 2 percent slopes. This nearly level, poorly drained soil is on severely channeled flood plains. Old meandering channels, 5 to 10 feet deep, generally contain water year-round. Areas of this soil are subject to frequent flooding. Individual areas are irregular in shape and range from 10 to 200 acres.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is also black silty clay loam about 26 inches thick. The next layer is very dark gray silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is very dark gray grading to light brownish gray silty clay loam. Small areas that have higher clay content in the substratum are sometimes located along channels that dissect this map unit.

Included with this soil in mapping are small areas of Hanlon and Lawson soils. Hanlon soils are higher in sand content and are near large channels. Lawson soils are lower in clay content and higher in silt content and are found in convex areas. These inclusions make up less than 10 percent of this map unit.

Permeability of this Colo soil is moderate, and surface runoff is slow. The available water capacity is high. This soil has a seasonal high water table. The content of organic matter in the surface layer is 4 to 6 percent. The surface layer and subsurface layer are neutral or slightly acid. The substratum is generally medium in available phosphorus and very low in available potassium. The surface layer has fair tilth.

A few areas of this soil are cultivated between the channels, but most areas are in permanent pasture and woodland. This soil is generally unsuited to cultivated crops and hay. It is moderately suited to pasture and trees. This soil is generally unsuited to sanitary facilities and building site development.

This soil is generally unsuited to cultivation. Trees must be removed, channels straightened or filled, levees built, and drainage ditches dug before this soil can be cropped. Pasture and trees should be protected from flooding.

This Colo soil is in capability subclass Vw.

1220—Nodaway silt loam, channeled, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on severely channeled flood plains. Old meandering channels 5 to 10 feet deep generally contain water year-round. This soil is subject to frequent flooding. Individual areas are long and moderately wide and parallel to streamflow. They are 40 to over 200 acres.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. Below the surface layer is a stratified, silt loam substratum to a depth of about 57 inches. It is very dark gray, very dark grayish brown, dark grayish brown, and grayish brown. Below 57 inches is a black, silty clay loam buried soil. In places, only 24 inches of stratified, silt loam sediment covers the buried soil. In places, the surface layer is dark grayish brown and contains a few thick strata of different color.

Included with this soil in mapping are small areas of poorly drained Colo and Zook soils in old channels that are filled with water at least part of the year. The Colo and Zook soils are on lower parts of the bottom lands that have not received recent deposits of silty sediment. The Zook soils commonly are some distance from the main stream channel. These inclusions make up about 10 percent of the map unit.

Permeability of this Nodaway soil is moderate, and surface runoff is slow. This soil has a seasonal high water table. The available water capacity is very high. The content of organic matter in the surface layer is 1 to 2 percent. Typically, the surface layer and substratum are neutral. The substratum is generally medium in available phosphorus and available potassium. This soil has good tilth.

A few areas of this soil are cultivated between old channels, but most areas are in permanent pasture and trees. This soil is generally unsuitable for cultivated crops and hay. It is moderately suited to pasture and trees. This soil is generally unsuitable for sanitary facilities and building site development.

This soil is generally unsuited to cultivation. Trees must be removed, channels straightened or filled, levees

built, and drainage ditches dug before this soil can be cropped. Pasture and trees should be protected from flooding.

This soil is moderately suited to trees. A few small areas remain in native hardwoods. Natural and planted seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by careful site preparation or by spraying, cutting, or girdling. There are no hazards or limitations for planting or harvesting trees.

This Nodaway soil is in capability subclass Vw.

1485—Spillville loam, channeled, 0 to 2 percent slopes. This nearly level, moderately well drained and somewhat poorly drained soil is on channeled flood plains adjacent to major streams and tributaries in the western part of the county. Old meandering channels 5 to 10 feet deep generally contain water year-round. This soil is subject to frequent flooding for brief periods. Individual areas are long and moderately wide and parallel to streamflows. They are 40 to 200 acres.

Typically, the surface layer is very dark gray loam about 7 inches thick. The subsurface layer is black loam about 33 inches thick. The substratum to a depth of about 60 inches is very dark grayish brown loam that has sandy loam and loamy sand strata. In some areas, this soil has up to 18 inches of sandy loam overwash.

Included with this soil in mapping are small areas of poorly drained Colo soils. Colo soils are on concave areas and are higher in clay content. They make up about 10 percent of the map unit.

Permeability of this Spillville soil is moderate, and surface runoff is slow. This soil has a seasonal high water table. The available water capacity is high. The content of organic matter in the surface layer is 3 to 5 percent. The surface layer and subsurface layer are neutral or slightly acid. The soil is low in available phosphorus and very low to low in available potassium. Tilth is good.

A few areas of this soil are cultivated between old channels, but most areas are in permanent pasture and trees. This soil is generally unsuitable for cultivated crops and hay. It is moderately suited to pasture. This soil is generally unsuitable for sanitary facilities and building site development.

This soil is generally unsuitable for cultivation. Trees must be removed, channels straightened or filled, levees built, and drainage ditches dug before this soil can be cropped. Pasture and trees should be protected from flooding.

This Spillville soil is in capability subclass Vw.

1936—Colo-Hanlon-Lawson complex, channeled, 0 to 2 percent slopes. This map unit consists of nearly level, moderately well drained, somewhat poorly drained, and poorly drained soils. These soils are on severely channeled flood plains, mainly along the natural channel of the Iowa River. Old channels generally contain water year-round. Areas of these soils are subject to frequent flooding. Individual areas are irregular or coarsely lobed in shape, and in places are a continuous unit for many miles. They range from 10 to over 1,000 acres. Individual areas contain about 50 percent Colo soil, about 25 percent Hanlon soil, and from 10 to 25 percent Lawson soil (fig. 17). The poorly drained Colo soil is on first bottoms along the Hanlon and Lawson soils. Many of the intermittent ponds occupy old oxbow channels in areas of Colo soil. The moderately well drained Hanlon soil is along the natural stream channel. The Hanlon soil is higher than the Colo and Lawson soils. The somewhat poorly drained Lawson soil is on first and second bottoms along the Hanlon soils and on convex areas near the Colo soil. The three soils are so intricately mixed that it is not practical to separate them in mapping.

Typically, the Colo soil has a surface layer of black silty clay loam about 10 inches thick. The subsurface layer is also black silty clay loam about 26 inches thick. The next layer is very dark gray silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is very dark gray grading to light brownish gray silty clay loam. In places, the surface layer is higher in clay content. In places, deposits of light colored silty overwash are 6 to 24 inches thick.

Typically, the Hanlon soil has a surface layer of very dark brown sandy loam about 8 inches thick. The subsurface layer is fine sandy loam about 23 inches thick. It is very dark gray in the upper part and very dark grayish brown in the lower part. The subsoil is very dark grayish brown, friable fine sandy loam about 9 inches thick. The substratum to a depth of about 60 inches is stratified, dark grayish brown and grayish brown fine sandy loam and loamy fine sand. In some areas, the surface layer and subsurface layer are loamy sand or sand and have low available water capacity.

Typically, the Lawson soil has a surface layer of black silty clay loam about 6 inches thick. The subsurface layer is silty clay loam about 24 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled silty clay loam. In places, the surface layer is loamy.

Permeability is moderately rapid in the Hanlon soil and moderate in the Colo and Lawson soils. Runoff is slow. The available water capacity is high in Colo soil, moderate in Hanlon soil, and very high in Lawson soil. All three soils have a seasonal high water table. The content of organic matter in the surface layer is 5 to 7 percent in Colo soil, 2 to 4 percent in Hanlon soil, and 4.5 to 6 percent in Lawson soil. Typically, the solum of all three soils is neutral or slightly acid. The available phosphorus in the subsoil is very low for Hanlon soil, and available phosphorus in the substratum is medium for Colo soils and low for Lawson soil. The available potassium in the subsoil of Hanlon soil and in the substratum of Colo and Lawson soils is very low. Tilth is fair to good.

Figure 17.—Typical area of Colo-Hanlon-Lawson complex, channeled, 0 to 2 percent slopes, along the Iowa River. These areas provide natural habitat for wildlife in Marshall County.

Most areas of this complex are in woodland and permanent pasture. The soils are generally unsuitable for cultivated crops and hay. They are moderately suited to pasture and trees. The soils are poorly suited to sanitary facilities and building site development.

These soils are generally unsuitable for cultivation. Trees must be removed, channels straightened or filled, levees built, and drainage ditches dug before these soils can be cropped (fig. 18).

These soils are moderately suited to trees and pasture. Trees need protection from grazing livestock and flooding. Wetness is a limitation for trees in places. Providing drainage and flood protection improves pastures. Overgrazing or grazing when the soils are wet causes surface compaction and results in poorer tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

The soils in this complex are in capability subclass Vw.

4011B—Colo-Ely-Urban land complex, 2 to 5 percent slopes. This map unit consists of gently sloping, poorly drained and somewhat poorly drained soils and areas of urban land on foot slopes, alluvial fans, and narrow flood plains. Areas of the Colo soil in this complex are subject to frequent flooding. Individual areas of this unit are long and narrow. They range from 5 to 100 acres.

Individual areas are from 25 to 55 percent Colo soil, from 20 to 30 percent Ely soil, and from 15 to 50 percent Urban land. The Colo and Ely soils and Urban land areas are so intricately mixed or areas are so small that it is not practical to separate them in mapping.

Typically, the Colo soil has a surface layer of black silty clay loam about 10 inches thick. The subsurface layer is also black silty clay loam about 26 inches thick. The next layer is very dark gray silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is light brownish gray silty clay loam. In places, the combined thickness of the surface and subsurface layers is less than 36 inches. In places, deposits of light colored silty overwash are 6 to 18 inches thick. In places, the soil has been drastically altered. Some low

Figure 18.—Areas protected from flooding in the Colo-Hanlon-Lawson complex, channeled, 0 to 2 percent slopes, provide recreation sites.

areas have been filled or leveled during construction. Other small areas have been excavated, built up, or smoothed.

Typically, the Ely soil has a surface layer of black silty clay loam about 9 inches thick. The subsurface layer is silty clay loam about 17 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil to a depth of about 60 inches is dark grayish brown, friable silty clay loam in the upper part and grayish brown and light brownish gray, mottled, friable silty clay loam in the lower part. In places, deposits of light colored silty overwash are 6 to 18 inches thick. In places, the soil has been drastically altered. Some low areas have been filled or leveled during construction. Other small areas have been excavated, built up, or smoothed.

The Urban land part of the complex is covered by streets, parking lots, buildings, and other structures that obscure or alter the soils so that identification is not feasible.

Included in this complex are small areas of well drained and moderately well drained Judson soils. Judson soils are on foot slopes and are not subject to flooding. These soils make up 5 to 10 percent of the complex.

Permeability of the Colo and Ely soils is moderate. The available water capacity is high for the Colo soil and very high for the Ely soil. Surface runoff is slow for the Colo soil and medium for the Ely soil. Both soils have a seasonal high water table. Many areas of this complex are artificially drained through sewer systems, gutters, drainage tiles, and, to a lesser extent, surface ditches. The content of organic matter in the surface layer is 5 to 7 percent in the Colo soil and 5 to 6 percent in the Ely soil. Typically, the solum of both soils is neutral to medium acid. The available phosphorus is medium in the substratum of the Colo soil and very low in the subsoil of the Ely soil. The substratum of the Colo soil and the subsoil of the Ely soil are very low in available potassium. Both soils have fair tilth.

The Colo and Ely parts of the complex are used for dwellings, local streets, lawns, shade trees, and gardens. These soils are well suited to lawns and gardens. They are moderately suited to shade trees and shrubs. They are poorly suited to building site development and local roads and streets.

The Colo and Ely soils are well suited to grasses,

flowers, and vegetables if excess water is removed. Several methods of artificial drainage can be successfully used on this soil. The best method of a particular area needs to be selected by onsite investigation. These soils are suited to hardwood trees and shrubs. Perennial plants that are selected for planting should have a fairly high tolerance for wetness. These soils are generally not suited to coniferous plants because of wetness. Soil erosion generally is not a major problem unless the soils are disturbed and left bare and exposed for a consider able period of time or are used as a water course.

The soils in this complex are not assigned to a capability subclass.

4119—Muscatine-Urban land complex, 1 to 3 percent slopes. This map unit consists of very gently sloping, somewhat poorly drained Muscatine soil and Urban land on moderately wide divides. Individual areas range from 5 to 150 acres in a broad, oblong pattern.

Individual areas are from 50 to 85 percent Muscatine soil and from 15 to 50 percent Urban land. The Muscatine soil and Urban land are so intricately mixed or areas are so small that it is not practical to separate them in mapping.

Typically, the Muscatine soil has a surface layer of black silty clay loam about 9 inches thick. The subsurface layer is silty clay loam about 10 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil is friable silty clay loam about 36 inches thick. It is very dark grayish brown and dark grayish brown in the upper part grading to mottled grayish brown and light olive brown in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay loam. In places, the soil has been drastically altered. Small areas have been excavated or smoothed during construction.

The Urban land part of this complex is covered by streets, parking lots, buildings, and other structures that obscure or alter the soils so that identification is not feasible.

Permeability of this Muscatine soil is moderate, and surface runoff is slow. The available water capability is very high. This soil has a seasonal high water table. The content of organic matter in the surface layer is 4 to 5 percent. The subsoil is medium acid to neutral, low in available phosphorus, and very low in available potassium. This soil has fair tilth.

Some areas of this complex are artificially drained through sewer systems, gutters, and drainage tiles. Any buildings that have basements below ground level should be artificially drained.

The Muscatine part of the complex is used mainly for industrial building sites. Some areas are used for open space, lawns, gardens, and residential development. This soil is well suited to vegetable and flower gardens and moderately suited to lawns, trees, and shrubs, playgrounds, and residential sites with public sewer and industrial building sites.

This complex is well suited to grasses, flowers, and vegetables. It is moderately suited to trees and shrubs. If artificially drained the soil is more suited to trees. Soil erosion generally is not a major problem on this complex unless the soils are disturbed and left bare and exposed for a considerable period of time or are used as a water course.

This complex is not assigned to a capability subclass.

4120B—Tama-Urban land complex, 2 to 5 percent slopes. This map unit consists of gently sloping, well drained Tama soil and Urban land on convex ridgetops and side slopes. Individual areas range from 7 to 100 acres and are irregular in shape.

Individual areas are from 50 to 85 percent Tama soil and from 15 to 50 percent Urban land. The Tama soil and Urban land are so intricately mixed or areas are so small that it is not practical to separate them in mapping.

Typically, the Tama soil has a surface layer of very dark brown silty clay loam about 7 inches thick. The subsurface layer is silty clay loam about 9 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The subsoil is friable silty clay loam about 28 inches thick. It is brown in the the upper part; yellowish brown in the middle part; and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is brown and grayish brown silty clay loam that has a few light brownish gray mottles. In places, the soil has been drastically altered. Some areas have been excavated or smoothed during construction.

The Urban land part of the complex is covered by streets, parking lots, buildings, and other structures that obscure or alter the soil so that identification is not feasible.

Included in this complex are small areas of Garwin soils along the upper parts of drainageways. These soils have a thicker, dark surface layer and are poorly drained. They make up 5 percent of this map unit.

Permeability of the Tama soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter in the surface layer is 3 to 4 percent. The subsoil is medium acid or slightly acid, medium in available phosphorus, and very low in available potassium. This soil has fair tilth.

The Tama part of the complex is used for parks, industrial and residential building sites, lawns, and gardens. It is well suited to lawns, trees, shrubs, and building sites and moderately suited to a public sewer system.

This complex is well suited to grasses, flowers, vegetables, shrubs, and trees. Soil erosion is a hazard if the soil is disturbed and left bare and exposed for a considerable period.

This complex is not assigned to a capability subclass.

4120C—Tama-Urban land complex, 5 to 9 percent slopes. This map unit consists of moderately sloping,

well drained Tama soil and Urban land on convex ridgetops and side slopes. Individual areas range from 10 to over 100 acres and are irregular in shape.

Individual areas are from 50 to 85 percent Tama soil and from 15 to 50 percent Urban land. The Tama soil and Urban land are so intricately mixed or areas are so small that it is not practical to separate them in mapping.

Typically, the Tama soil has a surface layer of very dark grayish brown light silty clay loam about 10 inches thick. The subsoil is friable silty clay loam about 30 inches thick. It is dark brown and brown in the upper part and dark yellowish brown and yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown silty clay loam that has a few light brownish gray mottles.

The Urban land part of this complex is covered by streets, parking lots, buildings, and other structures that obscure or alter the soils so that identification is not feasible.

Included in this complex are small areas of Garwin soils along the upper parts of drainageways. These soils have a thicker, dark surface layer and are poorly drained. They make up 5 percent of this complex.

Permeability of this Tama soil is moderate, and surface runoff is medium. The available water capacity is high. The content of organic matter in the surface layer is 3 to 4 percent. The subsoil is medium acid or slightly acid, medium in available phosphorus, and very low in available potassium. This soil has fair tilth.

The Tama part of the complex is used for parks, industrial and residential building sites, lawns, and gardens. It is well suited to lawns, trees, shrubs, and building sites. It is moderately suited to residential sites without a public sewer system.

This complex is well suited to grasses, flowers, vegetables, shrubs, and trees. Soil erosion is a hazard if the soil is disturbed and left bare and exposed for a considerable period.

This complex is not assigned to a capability subclass.

4133—Colo-Urban land complex, 0 to 2 percent slopes. This map unit consists of nearly level, poorly drained Colo soil and Urban land on flood plains and in the lower parts of gently sloping, upland drainageways near the water course. Areas of this map unit are subject to occasional flooding. Individual areas range from 50 to 100 acres in a broad irregular pattern.

Individual areas are 50 to 85 percent Colo soil and from 15 to 50 percent Urban land. The Colo soil and Urban land are too intricately mixed or areas are so small that it is not practical to separate them in mapping.

Figure 19.—Sand and gravel deposits along the Iowa River and Minerva Creek are an important natural resource in Marshall County.

Typically, the Colo soil has a surface layer of black silty clay loam about 10 inches thick. The subsurface layer is also black silty clay loam about 26 inches thick. The next layer is very dark gray silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is light brownish gray silty clay loam. In places, the soil has been drastically altered. Small areas have been excavated, built up, or smoothed during construction.

The Urban land part of the complex is covered by streets, parking lots, buildings, and other structures that obscure or alter the soils so that identification is not feasible.

Permeability of this Colo soil is moderate, and surface runoff is slow. The available water capacity is high. This soil has a seasonal high water table. The content of organic matter in the surface layer is 5 to 7 percent. Typically, the upper part of the surface layer is neutral to medium acid. Below this, the soil is neutral or slightly acid. The substratum is generally medium in available phosphorus and very low in available potassium. The surface layer has fair tilth.

Most areas of this complex are artificially drained through sewer systems, gutters, drainage tiles, and, to a lesser extent, surface ditches. Most areas are protected from flooding by existing levees.

The Colo part of the complex is used mainly for industrial building sites and open space. Some areas are used for residential development, lawns, and gardens. This soil is well suited to lawns, vegetables, and flower gardens. It is moderately suited to hardwood trees and shrubs. It is poorly suited to recreational areas, sanitary facilities, and building site development.

This complex is well suited to grasses, vegetables, and flowers. It is moderately suited to trees and shrubs. Artificial drainage makes this soil more suited to trees. Soil erosion generally is not a major hazard unless the soil is disturbed and left bare and exposed for a considerable period or is used as a water course.

This complex is not assigned to a capability subclass.

5010—Pits, sand and gravel. This map unit consists of pits where sand and gravel have been removed. The pits are 20 to more than 30 feet deep. Many of these pits are still in operation (fig 19), but some areas where the commercial sand and gravel strata have been exhausted are inactive. Individual areas are irregular in shape and commonly range from 5 to more than 20 acres.

The soil materials are quite variable. In general, the permeability is moderately rapid to very rapid. The available water capacity is low. The content of organic matter is less than 0.5 percent. Typically, reaction ranges from strongly acid to neutral. The soil material is commonly very low in available phosphorus and available potassium.

Water accumulates in most of these pits. Many of the inactive sand and gravel pits contain fish and are used for fishing. However, many are on private property and are not open to the public.

This map unit is not assigned to a capability subclass.

5030—Pits, limestone quarry. This map unit consists of Pits that have been mined and limestone has been removed. Two large pits are active in the county. These areas have open pits with 20 to 50 feet of surface materials above the limestone (fig. 20). A few small, inactive pits are in the northeastern part of the county. Individual areas are irregular in shape. The small pits range from 3 to 10 acres. The two large pits range from 90 to 150 acres.

This map unit is not assigned to a capability subclass.

Figure 20.—Limestone is an important natural resource in Marshall County.

prime farmland

Prime farmland is one of several kinds of important farmlands defined by the United States Department of Agriculture. Prime farmland is of major importance in providing the Nation's short- and long-range needs for food and fiber. The supply of high quality farmland is limited. The U. S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, must encourage and facilitate the use of our Nation's prime farmland with wisdom and foresight.

Prime farmland, as defined by the U. S. Department of Agriculture, is the land that is best suited to producing food, feed, forage, fiber, and oilseed crops. It has sufficient soil quality, a suitable growing season, and an adequate moisture supply to economically produce a sustained high yield of crops if it is treated and managed using acceptable farming methods. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland may now be in crops, pasture, woodland, or other land uses. It cannot be urban and built-up land or water areas. Prime farmland must either be used for producing food or fiber or be available for these uses.

Prime farmland generally has an adequate and dependable supply of moisture from precipitation or irrigation. It also has favorable temperature, a suitable growing season, and acceptable soil reaction. There are few or no rocks, and the soil is permeable to water and air. Prime farmland is not excessively erodible and is not saturated with water for long periods. It is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent.

For more detailed information on the criteria used to designate prime farmland, consult the local staff of the Soil Conservation Service.

About 182,000 acres or nearly 50 percent, of the land in Marshall County meets the soil requirement for prime farmland. Areas are scattered throughout the county. Approximately 175,000 acres of this prime farmland is used for crops. Crops grown on this land, mainly corn and soybeans, account for an estimated three-fifths of the county's total agricultural income each year.

A recent trend in land use in some parts of the county has resulted in the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and difficult to cultivate, and generally less productive.

The map units that make up prime farmland in Marshall County are listed in this section. This list does not constitute a recommendation for a particular land use. Table 4 shows the extent of each map unit listed. The location of each map unit is shown on the detailed soil maps. The soil qualities that affect use and management are described in the section "Detailed soil map units."

Some soils have limitations, such as a high water table or a flooding hazard, that must be overcome by such measures as drainage or flood control if they are to be considered prime farmland. These limitations are shown in parentheses following some of the map units listed in this section. *Water table* indicates that the soil has a seasonal high water table. These soils qualify as prime farmland only in areas where they are drained sufficiently for crop production. *Flooding* indicates the existence of a flooding hazard. These soils qualify as prime farmland only in areas which are flooded during the growing season once or less in two years. Onsite evaluation is necessary to determine if these limitations have been overcome by corrective measures.

The following soil map units in Marshall County are prime farmland except where the limitations listed in parentheses have not been overcome, or where the soil areas are urban or built-up land. Urban and built-up land is any contiguous area of 10 acres or more that is used for residences, industrial sites, commercial sites, or construction sites; institutional sites or public administrative sites; railroad yards; small parks; cemeteries; airports; golf courses; sanitary landfills; sewage treatment plants; water control structures and spillways; shooting ranges; and other similar uses.

5B—Ackmore-Colo complex, 2 to 5 percent slopes (water table, flooding)
7—Wiota silty clay loam, 1 to 3 percent slopes
8B—Judson silty clay loam, 2 to 5 percent slopes
11B—Colo-Ely complex, 2 to 5 percent slopes (water table, flooding)
43—Bremer silty clay loam, 0 to 2 percent slopes (water table)
51—Vesser silt loam, 0 to 2 percent slopes (water table, flooding)
54—Zook silty clay loam, 0 to 2 percent slopes (water table)
55—Nicollet loam, 1 to 3 percent slopes
95—Harps loam, 0 to 2 percent slopes (water table)

107—Webster silty clay loam, 0 to 2 percent slopes (water table)
118—Garwin silty clay loam, 0 to 2 percent slopes (water table)
119—Muscatine silty clay loam, 1 to 3 percent slopes
120—Tama silty clay loam, 0 to 2 percent slopes
120B—Tama silty clay loam, 2 to 5 percent slopes
122—Sperry silt loam, 0 to 2 percent slopes (water table)
133—Colo silty clay loam, 0 to 2 percent slopes (water table)
133+—Colo silt loam, 0 to 2 percent slopes (water table, flooding)
133B—Colo silty clay loam, 2 to 5 percent slopes (water table)
135—Coland silty clay loam, 0 to 2 percent slopes (water table)
138B—Clarion loam, 2 to 5 percent slopes
150—Hanska loam, 0 to 2 percent slopes (water table)
162B—Downs silt loam, 2 to 5 percent slopes
163B—Fayette silt loam, 2 to 5 percent slopes
175B—Dickinson fine sandy loam, 2 to 5 percent slopes
177—Saude loam, 1 to 3 percent slopes
178—Waukee loam, 1 to 3 percent slopes
201B—Coland-Terril complex, 2 to 5 percent slopes (water table, flooding)
220—Nodaway silt loam, 0 to 2 percent slopes
226—Lawler loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
420B—Tama silty clay loam, benches, 2 to 5 percent slopes
428B—Ely silty clay loam, 2 to 5 percent slopes
430—Ackmore silt loam, 0 to 2 percent slopes (water table, flooding)
442B—Dickinson-Sparta-Tama complex, 2 to 5 percent slopes
462B—Downs silt loam, benches, 2 to 5 percent slopes
484—Lawson silty clay loam, 0 to 2 percent slopes (water table)
485—Spillville loam, 0 to 2 percent slopes
507—Canisteo silty clay loam, 0 to 2 percent slopes (water table)
536—Hanlon fine sandy loam, 0 to 2 percent slopes (flooding)
595—Harpster silty clay loam, 0 to 2 percent slopes (water table)
688—Koszta silt loam, 1 to 3 percent slopes

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

crops and pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 79 percent, or 290,000 acres, of Marshall County is used for crop production. About 33,000 acres, or 9 percent, is in pasture. Some rotation pasture and hayland used as pasture is included in the cropland acreage.

Corn, soybeans, and legume or grass-legume hay are the principal crops. Minor crops include oats and sorghum. Alfalfa is the major crop grown for hay. Red clover and mixtures of alfalfa and bromegrass or orchardgrass comprise the majority of the remaining hay crops.

Most of the permanent pasture in the county is bluegrass. Some of these pastures are of low quality, but under improved management, including liming, fertilizing, and rotation grazing, the quality and quantity of forage can be improved. Several pastures have been renovated with legumes and grass-legume mixtures.

Soil erosion is the major soil problem on about two-thirds of the cropland and pasture in Marshall County. Where the slope is more than 2 percent, erosion is a hazard. Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. This is especially damaging on soils that have a clayey subsoil. Erosion also reduces productivity on soils that tend to be droughty. Second, soil erosion on farmland results in sediment entering streams. Reducing erosion minimizes the pollution of streams by sediment and improves the quality of water for municipal use, for recreation, and for wildlife.

In many sloping fields, preparing a good seedbed and tilling are difficult on clayey spots because the original friable surface layer has been eroded away. Such spots are common in areas of moderately eroded soils.

Erosion control practices provide protective surface cover, reduce runoff, and increase infiltration. A cropping system that keeps vegetative cover on the soil for extended periods can hold soil erosion losses to amounts that do not reduce the protective capacity of the soils. On livestock farms which require pasture and hay, the legume and grass forage crops in the cropping system reduce erosion and also provide nitrogen and improve tilth for the following crop.

In some areas, slopes are so short and irregular that contour tillage or terracing is not practical. Cropping systems that provide substantial vegetative cover are required in these areas to control erosion unless conservation tillage is practiced. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, increases infiltration and reduces runoff and erosion. This practice can be adapted to most soils in the survey area but is more difficult to apply successfully on the eroded soils and the soils that have a clayey surface layer. No-tillage for corn, which is increasingly common, effectively helps to reduce erosion on sloping land and can be adapted to many soils in the survey area. It is more difficult to practice successfully, however, on soils that have a clayey surface layer.

Terraces and diversions shorten the slope and reduce runoff and erosion. They are most practical on deep, well drained soils that have regular slopes. Other soils are less suitable for terraces and diversions because of irregular slopes, excessive wetness in the terrace channels, or a clayey subsoil that would be exposed in terrace channels.

Contouring and contour stripcropping are also erosion control practices in the survey area. They are best adapted to soils that have smooth, uniform slopes.

Wind erosion, or soil blowing, is a hazard on sandy soils. Wind erosion can damage these soils in a few hours if winds are strong and the soils are dry and bare of vegetation or surface mulch. Maintaining vegetative cover, surface mulch, or rough surfaces through proper tillage minimizes wind erosion on these soils.

Information on the design of erosion control practices for each kind of soil can be found in the Technical Guide, available at local offices of the Soil Conservation Service.

Soil drainage is the major management need on about 12 percent of the land used for crops and pasture in the county. Some soils are naturally so wet that the production of crops common to the area is generally not possible. These are some of the poorly drained and very poorly drained soils, which make up about 44,000 acres. Unless artificially drained, the poorly drained and part of the somewhat poorly drained soils are so wet that crops are damaged during most years.

The design of both surface and subsurface drainage systems varies with the kind of soil. A combination of surface drainage and tile drainage is needed in most areas of the poorly drained and very poorly drained soils used for intensive row cropping. Drains have to be more closely spaced in soils with slow permeability than in the more permeable soils. Tile drainage is very slow in soils that have high clay content in the subsoil. Finding adequate outlets for tile drainage systems is difficult in many bottom land areas.

Information on design of drainage systems for each kind of soil is contained in the Technical Guide, available in local offices of the Soil Conservation Service.

Soil fertility is naturally low in many soils of the uplands in the county. Most soils are naturally acid and, if they have never been limed, they require applications of ground limestone to raise the pH level sufficiently for good growth of alfalfa and other crops that grow only on near neutral soils. Available phosphorus and potassium levels are naturally low in many of these soils.

On all soils, additions of lime and fertilizer should be based on the results of soil tests, on the need of the crop, and on the expected level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime to apply.

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils with good tilth are granular and porous.

Most of the soils used for crops in the survey area have a silt loam or silty clay loam surface layer that is dark and moderate in content of organic matter. The moderately eroded and severely eroded soils have a surface layer that is lower in organic matter content and higher in clay content than the uneroded phase. Generally the structure of such soils is weak, and intense rainfall causes the formation of a crust on the surface. The crust is hard when it is dry, and it is nearly impervious to water. Once the crust forms, it reduces infiltration and increases runoff. Regular additions of crop residue, manure, and other organic material can help to improve soil structure and to reduce crust formation.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed

because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s*, or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, woodland, wildlife habitat, or recreation.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity.

The acreage of soils in each capability class and subclass is shown in table 6. The capability classification of each map unit is given in the section "Detailed soil map units."

woodland management and productivity

Table E can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in

management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *windthrow hazard* are based on soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that a few trees may be blown down by normal winds; *moderate*, that some trees will be blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

windbreaks and environmental plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, hold snow on the fields, reduce energy requirements, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens.

Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

recreation

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

wildlife habitat

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, orchardgrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, apple, hawthorn, dogwood, hickory, blackberry, and elderberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, shore birds, muskrat, mink, and beaver.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

sanitary facilities

Table 12 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of

landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches

of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel or stones, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders or organic matter. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as high content of calcium carbonate. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct

surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

physical and chemical properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity; the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 16, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, and by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes are not considered flooding.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is,

perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*2*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 18, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquolls (*Hapl*, meaning minimal horizonation, plus *aquoll*, the suborder of the Mollisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Typic Haplaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*19*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*21*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Ackmore series

The Ackmore series consists of somewhat poorly drained and poorly drained soils on flood plains or alluvial fans. Permeability is moderate. These soils formed in recently deposited silt loam alluvium that is 20 to 36 inches thick over black or very dark gray silty clay loam. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Ackmore soils are similar to Colo, Nodaway, and Zook soils and are commonly adjacent to them. Colo soils have a thicker, darker surface soil and do not have an older buried surface layer. Nodaway soils are moderately well drained and do not have a dark buried A horizon

within a depth of 36 inches. They are in positions similar to the Ackmore soils. Zook soils have a finer textured surface layer and commonly are some distance from the main stream channel.

Typical pedon of Ackmore silt loam, 0 to 2 percent slopes, 1,500 feet west and 120 feet north of the southeast corner of sec. 19, T. 84 N., R. 17 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) silt loam, very dark grayish brown (10YR 3/2) kneaded, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure parting to weak fine granular; friable; common fibrous roots; slightly acid; abrupt smooth boundary.

C—7 to 27 inches; stratified, very dark gray (10YR 3/1), very dark grayish brown (10YR 3/2), and dark grayish brown (10YR 4/2) silt loam, and a few grayish brown (10YR 5/2) strata; few fine prominent yellowish brown (10YR 5/6) mottles; breaking to thin platy fragments; friable; few worm channels; few fibrous roots; slightly acid; clear smooth boundary.

IIA11b—27 to 35 inches; black (N 2/0) silty clay loam; moderate very fine subangular blocky structure parting to weak fine granular; friable; few fibrous roots; neutral; gradual smooth boundary.

IIA12b—35 to 44 inches; black (N 2/0) silty clay loam; weak medium prismatic structure parting to weak fine subangular blocky; friable; few fibrous roots; neutral; gradual smooth boundary.

IIA13b—44 to 60 inches; black (10YR 2/1) heavy silty clay loam; moderate medium prismatic structure parting to weak moderate subangular blocky; firm; neutral.

The A and C horizons range from 20 to 36 inches in thickness. Reaction is slightly acid or neutral. The A horizon has value of 2 or 3 and chroma of 1 or 2. It is silt loam or light silty clay loam. The strata in the C horizon has value of 2 to 5 and chroma of 1 or 2. The C horizon is silt loam or light silty clay loam. The IIA horizon has value of 2 and chroma of 0 or 1. Typically, it is silty clay loam but ranges to silt loam. Reaction of the IIA horizon ranges from medium acid to mildly alkaline.

Adair series

The Adair series consists of moderately well drained and somewhat poorly drained soils on convex side slopes, nose slopes, and shoulders of narrow interfluves on uplands. Permeability is slow. These soils are Late Sangamon paleosols that formed in glacial till with the exception of the surface layer to a depth of 10 to 20 inches. The surface layer is partly loess or loess and is pedisediment. Native vegetation was prairie grasses. Slope ranges from 9 to 14 percent.

These Adair soils are taxadjuncts to the Adair series because they do not have a mollic epipedon. The A horizon is less than 8 inches thick.

Adair soils are similar to Shelby soils and are commonly adjacent to Clarinda, Shelby, and Tama soils. Clarinda soils are poorly drained and are at a slightly higher elevation. Shelby soils have B2t horizons that are lower in clay content and are downslope from Adair soils. Tama soils have less clay in the subsoil and are upslope from Adair soils.

Typical pedon of Adair clay loam, 9 to 14 percent slopes, moderately eroded, 2,000 feet west and 90 feet north of the southeast corner of sec. 34, T. 82 N., R. 19 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) clay loam mixed with brown (10YR 4/3), very dark grayish brown (10YR 3/2) kneaded, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure parting to weak fine granular; friable; few fibrous roots; slightly acid; abrupt smooth boundary.

B1—6 to 12 inches; brown (10YR 4/3) clay loam; many fine faint brown (7.5YR 4/4) mottles; weak very fine subangular blocky structure; friable; few fibrous roots; medium acid; clear smooth boundary.

B21—12 to 18 inches; brown (7.5YR 4/4) clay loam, brown (7.5YR 4/4) kneaded; weak very fine subangular blocky structure; friable; few fibrous roots; few pebbles; medium acid; clear smooth boundary.

IIB22t—18 to 27 inches; reddish brown (5YR 4/4) silty clay; many fine faint red (2.5YR 4/6) mottles; moderate very fine angular blocky structure; very firm; thin discontinuous clay films; few fibrous roots; few pebbles; few fine dark accumulations of manganese and iron oxides; slightly acid; gradual smooth boundary.

IIB23t—27 to 33 inches; mottled yellowish brown (10YR 5/4), yellowish red (5YR 4/6), and grayish brown (2.5Y 5/2) silty clay; weak medium prismatic structure parting to moderate fine subangular blocky; very firm; thin discontinuous clay films; few fibrous roots; few pebbles; few fine dark accumulations of manganese and iron oxides; slightly acid; gradual smooth boundary.

IIB31t—33 to 40 inches; mottled yellowish brown (10YR 5/4, 5/6) and grayish brown (2.5Y 5/2) heavy clay loam; weak medium prismatic structure parting to moderate fine subangular blocky; firm; thin discontinuous clay films; few pebbles; slightly acid; gradual smooth boundary.

IIB32t—40 to 49 inches; mottled dark yellowish brown (10YR 4/4), strong brown (7.5YR 5/6), and light olive gray (5Y 6/2) clay loam; weak medium prismatic structure parting to weak fine subangular blocky; firm; thin discontinuous clay films; few pebbles; few fine dark accumulations of manganese and iron oxides; slightly acid; gradual smooth boundary.

IIB33t—49 to 60 inches; mottled yellowish brown (10YR 5/4) and gray (5Y 6/1) clay loam; weak medium

subangular blocky structure; firm; few pebbles; few fine dark accumulations of manganese and iron oxides; slightly acid.

Thickness of the solum ranges from 40 to 65 inches. The thickness of the loess and pedisediment ranges from 15 to 25 inches but decreases as slope and erosion increase.

The Ap horizon is mixed very dark gray (10YR 3/1) very dark grayish brown (10YR 3/2), dark brown (10YR 3/3), or brown (10YR 4/3). It ranges from 3 to 9 inches in thickness. The A horizon ranges from silty clay loam to clay loam or loam. The upper part of the IIB2t horizon has hue of 10YR, 5YR, or 7.5YR; value of 4 or 5; and chroma of 4 or 6. It has many contrasting mottles. Clay content commonly ranges from 38 to 46 percent but may range as high as 56 percent.

Bremer series

The Bremer series consists of poorly drained soils on low stream benches or second bottoms. Permeability is moderately slow. These soils formed in silty alluvium. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Bremer soils are similar to Colo and Zook soils and are commonly adjacent to Colo, Judson, Nevin, and Zook soils. Colo soils have a mollic epipedon that is 36 inches or more thick, have lower clay content, and do not have clay films. They are generally closer to the water course than Bremer soils. Zook soils are on low flood plains and have a mollic epipedon more than 36 inches thick. Judson soils are well drained to moderately well drained, have less clay in the B horizon and are generally on foot slopes and alluvial fans. Nevin soils are somewhat poorly drained and have lower average clay content in the control section. They are slightly higher on the stream benches than Bremer soils.

Typical pedon of Bremer silty clay loam, 0 to 2 percent slopes, 600 feet west and 1,450 feet north of the southeast corner of sec. 27, T. 85 N., R. 19 W.

Ap—0 to 8 inches; black (10YR 2/1) light silty clay loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; few fibrous roots; neutral; abrupt smooth boundary.

A12—8 to 15 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak and moderate very fine subangular blocky structure; friable; few fibrous roots; neutral; gradual smooth boundary.

B21t—15 to 21 inches; black (N 2/0) heavy silty clay loam, black (10YR 2/1) dry; moderate very fine and fine subangular blocky structure; firm; few fibrous roots; thin discontinuous clay films; slightly acid; gradual smooth boundary.

B22t—21 to 33 inches; very dark gray (10YR 3/1) heavy silty clay loam, very dark gray (10YR 3/1) kneaded; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; firm; few fibrous roots; thin discontinuous clay films; slightly acid; clear smooth boundary.

B23tg—33 to 41 inches; dark grayish brown (2.5Y 4/2) silty clay loam, dark grayish brown (2.5Y 4/2) kneaded; few fine distinct yellowish brown (10YR 5/4, 5/6) mottles; weak medium prismatic structure parting to moderate fine and medium subangular blocky; firm; thin discontinuous clay films; few dark accumulations of manganese and iron oxides; slightly acid; gradual smooth boundary.

B3tg—41 to 49 inches; gray (5Y 5/1) silty clay loam; many fine faint grayish brown (2.5Y 5/2) and common fine distinct yellowish brown (10YR 5/4, 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; thin discontinuous clay films on prism faces; few dark accumulations of manganese and iron oxides; slightly acid; gradual smooth boundary.

Cg—49 to 60 inches; gray (5Y 5/1) light silty clay loam; many fine faint grayish brown (2.5Y 5/2) and common fine distinct yellowish brown (10YR 5/4, 5/6) mottles; massive ~~structure~~ with some vertical cleavage; friable; few dark accumulations of manganese and iron oxides; slightly acid.

Thickness of the solum ranges from 40 to 60 inches. Reaction is slightly acid or neutral.

The A horizon has value of 2 or 3 and chroma of 1 or 0. The A horizon is silt loam or silty clay loam and is 24 to 34 percent clay. The upper part of the B horizon commonly has value of 2 or 3 but ranges to 4 or 5 as depth increases. It has hues of 10YR, 2.5Y, or 5Y. The B horizon is typically silty clay loam but ranges to silty clay. The C horizon has hue of 10YR to 5Y, value of 4 or 5, and chroma of 1.

Canisteo series

The Canisteo series consists of poorly drained, calcareous soils in low areas and swales on uplands. Permeability is moderate. These soils formed in loam or clay loam glacial till and local alluvium. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Canisteo soils are similar to Webster soils and are commonly adjacent to Clarion, Harps, Nicollet, Okoboji, and Webster soils. Clarion and Nicollet soils are better drained than Canisteo soils and are on more convex slopes. Harps soils have a calcic horizon and are on rims of depressional areas. Okoboji and Webster soils are not calcareous. Okoboji soils are in depressions. Webster soils are in positions similar to Canisteo soils.

Typical pedon of Canisteo silty clay loam, 0 to 2 percent slopes, 2,300 feet north and 348 feet east of the southwest corner of sec. 6, T. 84 N., R. 20 W.

Ap—0 to 6 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak fine granular

structure; friable; common fibrous roots; few small pebbles; few snail shells; strong effervescence; moderately alkaline; clear smooth boundary.

A12—6 to 11 inches; black (10YR 2/1) light clay loam, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; friable; common fibrous roots; strong effervescence; moderately alkaline; gradual smooth boundary.

A3—11 to 19 inches; black (10YR 2/1) and very dark gray (10YR 3/1) light clay loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; friable; common fibrous roots; strong effervescence; moderately alkaline; gradual smooth boundary.

B21g—19 to 25 inches; dark gray (10YR 4/1) light clay loam; few fine faint gray (5Y 5/1) and light olive gray (5Y 6/2) mottles; weak fine subangular blocky structure; friable; few small pebbles; common fibrous roots; strong effervescence; moderately alkaline; gradual smooth boundary.

B22g—25 to 35 inches; gray (5Y 5/1) and olive gray (5Y 5/2) clay loam; few fine faint light olive gray (5Y 6/2) and few fine distinct strong brown (7.5YR 5/6) mottles; weak very fine and fine subangular blocky structure; friable; few small pebbles; few fibrous roots; strong effervescence; mildly alkaline; clear smooth boundary.

B3g—35 to 40 inches; olive gray (5Y 5/2) and light olive gray (5Y 6/2) light clay loam; few fine distinct strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; few small pebbles; few fibrous roots; strong effervescence; mildly alkaline; clear smooth boundary.

C1g—40 to 47 inches; light gray (5Y 6/1) heavy loam; common medium distinct strong brown (7.5YR 5/6) mottles; massive; friable; few small pebbles; few fine dark accumulations of manganese and iron oxides; strong effervescence; mildly alkaline; gradual smooth boundary.

C2g—47 to 60 inches; light gray (5Y 6/1) heavy loam; many common distinct strong brown (7.5Y 5/6) mottles; massive; friable; few small pebbles; strong effervescence; mildly alkaline.

Thickness of the solum ranges from 20 to 50 inches. Typically, the solum is calcareous and mildly alkaline or moderately alkaline throughout. The control section is 20 to 35 percent clay and 15 to 35 percent fine and coarser sand. The mollic epipedon ranges from 14 to 24 inches thick.

The A horizon is black (N 2/0, 10YR 2/1) or very dark gray (10YR 3/1). It is silty clay loam, loam, or clay loam. The B horizon has hue of 10YR, 2.5Y, or 5Y; value of 4 to 6; and chroma of 1 or 2. It is silty clay loam, loam, or clay loam. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 through 4. It is light clay loam, loam, or sandy loam.

Chelsea series

Chelsea series consists of excessively drained soils on convex ridgetops, side slopes, and crests of escarpments along stream valleys. Permeability is rapid. These soils formed in eolian sand or in sandy alluvium reworked by the wind. Native vegetation was oak-hickory forest. Slope ranges from 5 to 18 percent.

Chelsea soils are similar to Sparta soils and are commonly adjacent to Dickinson, Downs, and Sparta soils. All of these soils are in similar positions. Dickinson soils have less sand in the control section and are higher in content of organic matter than Chelsea soils. Downs soils formed in loess and have silt loam and silty clay loam textures. Sparta soils have a thicker and darker surface layer.

Typical pedon of Chelsea loamy fine sand, 5 to 9 percent slopes, 1,000 feet south and 1,300 feet east of the northwest corner of sec. 21, T 84 N., R. 18 W.

A11—0 to 2 inches; very dark gray (10YR 3/1) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; many fibrous roots; slightly acid; abrupt smooth boundary.

A12—2 to 5 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; common fibrous roots; slightly acid; clear smooth boundary.

A21—5 to 8 inches; brown (10YR 4/3) fine sand with some mixing of dark brown (10YR 3/3), pale brown (10YR 6/3) dry; single grain; loose; slightly acid; gradual smooth boundary.

A22—8 to 31 inches; dark yellowish brown (10YR 4/4) fine sand, very pale brown (10YR 7/3) dry; single grain; loose; medium acid; gradual smooth boundary.

A23—31 to 38 inches; dark yellowish brown (10YR 4/4) fine sand, very pale brown (10YR 7/4) dry; single grain; loose; medium acid; gradual smooth boundary.

A&B—38 to 60 inches; brown (10YR 4/3) fine sand; weak thin platy structure; loose (A2); 1/4- to 1-inch thick brown (7.5YR 4/4) bands of light sandy loam starting at a depth of 50 inches (B2t); medium acid.

The solum ranges from 4 to many feet thick. There are no carbonates to a depth of 60 inches or more. The solum is dominantly fine sand to a depth of 40 inches or more.

The A horizon is typically medium acid or strongly acid in the upper part. Uneroded areas have a very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) A1 horizon as much as 6 inches thick. The upper part of the A2 horizon is brown (10YR 4/3), dark yellowish brown (10YR 4/4), or dark grayish brown (10YR 4/2). The lower part ranges from dark yellowish brown (10YR 4/4) to light yellowish brown (10YR 6/4).

Clarinda series

The Clarinda series consists of poorly drained soils on convex side slopes and in coves at the heads of drainageways. Permeability is very slow. These soils formed in gray, clayey paleosols of Yarmouth-Sangamon age that formed in Kansan glacial till. Native vegetation was prairie grasses. Slope ranges from 9 to 14 percent.

These Clarinda soils are taxadjuncts to the Clarinda series because they do not have a mollic epipedon that is definitive for the Clarinda series. This difference does not alter the usefulness or behavior of the soil.

Clarinda soils are similar to Adair and Shelby soils and are commonly adjacent to Shelby, Killduff, and Tama soils. Adair soils have B horizons of redder hue than Clarinda soils. They contain more sand and commonly have a stone line in the upper part of the B horizon. Shelby soils have less clay in the B2 horizon, and have brownish B horizons. They formed in clay loam glacial till on slopes below the Clarinda soils. Killduff and Tama soils formed in loess. They have silt loam and silty clay loam textures and are upslope from Clarinda soils.

Typical pedon of Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded, 1,390 feet south and 350 feet west of the northeast corner of sec. 26, T. 82 N., R. 19 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) light silty clay loam mixed with brown (10YR 4/3), dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; common fibrous roots; slightly acid; clear smooth boundary.

A31—6 to 11 inches; brown (10YR 4/3) light silty clay loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; friable; common fibrous roots; slightly acid; clear smooth boundary.

A32—11 to 14 inches; grayish brown (10YR 5/2) silty clay loam, light gray (10YR 7/2) dry; few fine faint brown (7.5YR 4/4) mottles; moderate fine subangular blocky structure; friable; common fibrous roots; slightly acid; clear smooth boundary.

IIB22tg—14 to 24 inches; gray (10YR 5/1) silty clay; few fine faint yellowish brown (10YR 5/4 and 10YR 5/6) mottles; moderate fine subangular blocky structure; very firm; common roots; thin discontinuous clay films; slightly acid; gradual smooth boundary.

IIB23tg—24 to 41 inches; gray (10YR 5/1) clay; few fine faint strong brown (7.5YR 4/6) and light gray (10YR 6/1) mottles; moderate coarse prismatic structure parting to moderate fine subangular blocky; very firm; few roots; thin discontinuous clay films; few fine dark accumulations of manganese and iron oxides; slightly acid; gradual boundary.

IIB24tg—41 to 53 inches; gray (10YR 5/1) clay; few fine faint grayish brown (2.5Y 5/2) and strong brown (7.5YR 5/6 and 7.5YR 4/6) mottles; moderate coarse prismatic structure parting to moderate fine subangular blocky; very firm; few fibrous roots; thick discontinuous clay films; thin discontinuous light gray (10YR 7/1) silt coats; few fine dark accumulations of manganese and iron oxides; slightly acid; gradual smooth boundary.

IIB3tg—53 to 60 inches; gray (10YR 5/1) and light gray (10YR 6/1) clay; few fine faint strong brown (7.5YR 5/6) mottles; moderate coarse prismatic structure parting to moderate fine subangular blocky; very firm; thin discontinuous clay films; thin discontinuous light gray (10YR 7/1) silt coats; few fine dark accumulations of manganese and iron oxides; slightly acid.

Thickness of the solum is commonly more than 5 feet. Thickness of loess ranges from 10 to 18 inches with the exception of some eroded areas that have A horizons of less than 10 inches.

The Ap horizon ranges from very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) to brown (10YR 4/3). The IIBt horizon has hue of 10YR, 2.5Y, or 5Y; value of 4 or 5; and chroma of 1 or 2. It is silty clay or clay and has a maximum clay content of 45 to 58 percent. Reaction is neutral to strongly acid in the IIBt horizon.

Clarion series

The Clarion series consists of well drained soils on convex side slopes of Late Wisconsin till plains. Permeability is moderate. These soils formed in calcareous, loamy glacial till. Native vegetation was prairie grasses. Slope ranges from 2 to 18 percent.

Clarion soils are similar to Liscomb soils and are commonly adjacent to Nicollet, Storden, and Webster soils. Liscomb soils are more acid in the B horizon than Clarion soils. They are leached to a greater depth, and are less friable in the lower part of the B horizon. Nicollet and Webster soils are more nearly level and more poorly drained. Storden soils are on convex knobs and are calcareous.

Typical pedon of Clarion loam, 2 to 5 percent slopes, 1,340 feet east and 90 feet south of the northwest corner of sec. 20, T. 85 N., R. 20 W.

Ap—0 to 8 inches; black (10YR 2/1) light loam, very dark brown (10YR 2/2) kneaded, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few fibrous roots; neutral; abrupt smooth boundary.

A3—8 to 15 inches; very dark grayish brown (10YR 3/2) loam, some dark brown (10YR 3/3) and black (10YR 2/1) coatings on faces of peds, very dark grayish brown (10YR 3/2) kneaded, brown (10YR 4/3) dry; weak fine subangular structure; friable; few fibrous roots; slightly acid; clear smooth boundary.

B21—15 to 27 inches; brown (10YR 4/3) loam, very dark grayish brown (10YR 3/2) coatings on faces of

peds, dark brown (10YR 4/3) kneaded; weak fine and medium subangular blocky structure; friable; few fibrous roots; few pebbles; slightly acid; gradual smooth boundary.

B22—27 to 38 inches; dark yellowish brown (10YR 4/4) loam; few fine faint yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; friable; common pebbles; few fine dark accumulations of manganese and iron oxides; neutral; clear smooth boundary.

C1—38 to 42 inches; yellowish brown (10YR 5/4) light loam; few fine faint grayish brown (10YR 5/2) and few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; common pebbles; few fine dark accumulations of manganese and iron oxides; few secondary carbonates and soft carbonate accumulations; slight effervescence; mildly alkaline; gradual smooth boundary.

C2—42 to 60 inches; yellowish brown (10YR 5/4) light loam; few fine faint grayish brown (10YR 5/2) and few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; common pebbles; few fine dark accumulations of manganese and iron oxides; slight effervescence; mildly alkaline.

Thickness of the solum typically is 25 to 40 inches. The depth to carbonates is commonly the same as the solum thickness, and it is variable within short horizontal distances. The 10- to 40-inch control section averages about 18 to 27 percent clay.

The A horizon typically is loam but ranges to sandy loam, silt loam that has a high sand content, and clay loam.

The Clarion soils in map units 138C2, 138D2, and 138E2 are taxadjuncts to the Clarion series because they do not have a mollic epipedon that is definitive for the Clarion series. These soils have an A horizon that ranges from 3 to 9 inches in thickness.

Coland series

The Coland series consists of poorly drained soils on first bottoms, low benches, alluvial fans, and in the lower part of some drainageways on uplands. Permeability is moderate. These soils formed in loamy alluvial sediment. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Coland soils are similar to Spillville soils and are commonly adjacent to Lawler, Saude, Spillville, and Waukee soils. Spillville soils are on high lying areas on bottom lands. They are better drained than Coland soils and have an average clay content of 18 to 25 percent in the solum. Lawler, Saude, and Waukee soils are on higher lying stream benches. Lawler soils are underlain by sand and gravel at a depth of less than 40 inches and are somewhat poorly drained. Saude and Waukee soils are well drained and are underlain by sand and gravel at a depth of less than 40 inches.

Typical pedon of Coland silty clay loam, 0 to 2 percent slopes, 1,000 feet north and 700 feet east of the southwest corner of sec. 31, T. 85 N., R. 20 W.

A11—0 to 10 inches; black (10YR 2/1) light silty clay loam, moderate in sand content, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure parting to moderate granular; friable; few fibrous roots; neutral; clear smooth boundary.

A12—10 to 18 inches; black (N 2/0) light silty clay loam, high in sand content, black (N 2/0) dry; weak very fine subangular blocky structure parting to moderate granular; friable; few fibrous roots; neutral; gradual smooth boundary.

A13—18 to 30 inches; black (N 2/0) light clay loam, black (N 2/0) dry; moderate very fine and fine subangular blocky structure; firm; few fibrous roots; neutral; gradual smooth boundary.

AC—30 to 40 inches; black (N 2/0) and (10YR 2/1) light clay loam, very dark gray (10YR 3/1) dry; weak fine prismatic structure parting to weak fine and medium subangular blocky; firm; neutral; gradual smooth boundary.

C—40 to 60 inches; black (5Y 2/1) clay loam; weak medium prismatic structure; firm; neutral.

The thickness of the solum ranges from 36 to 48 inches. There are no free carbonates in the solum, and they commonly are absent to a depth of 48 inches or more. Reaction is slightly acid or neutral.

The A horizon is neutral or has hue of 10YR, value of 2 or 3, and chroma of 1 or less. Typically, the A horizon is silty clay loam that has moderate content of sand or clay loam but includes loam in the upper 10 inches. The 10- to 40-inch control section averages 27 to 35 percent clay and 15 to 30 percent fine sand or coarser. The AC horizon averages 27 to 35 percent clay and 15 to 30 percent sand. It has value of 3 or less to a depth of 36 inches or more.

Colo series

The Colo series consists of poorly drained soils on flood plains, on alluvial fans, and in the lower parts of some drainageways on uplands. Permeability is moderate. These soils formed from noncalcareous, silty alluvial sediment. Native vegetation was prairie grasses. Slope ranges from 0 to 5 percent.

Colo soils are similar to Ely soils and are commonly adjacent to Ely, Judson, Nodaway, and Zook soils. Ely and Judson soils are on foot slopes or toe slopes. Ely soils have a dark grayish brown B horizon and are somewhat poorly drained. Judson soils are well drained. Nodaway and Zook soils are in positions similar to Colo soils. Nodaway soils are lighter colored, less clayey, and are finely stratified. They are on flood plains that have recently received sediment. Zook soils have an average clay content of more than 35 percent in the 10- to 40-inch control section.

Typical pedon of Colo silty clay loam, 0 to 2 percent slopes, 2,540 feet south and 50 feet east of the northwest corner of sec. 36, T. 84 N., R. 20 W.

A11—0 to 11 inches; black (N 2/0) light silty clay loam; weak very fine subangular blocky structure parting to weak fine granular; friable; few fibrous roots; neutral; gradual smooth boundary.

A12—11 to 24 inches; black (N 2/0) silty clay loam; weak very fine and fine subangular blocky structure; friable; few fibrous roots; neutral; diffuse smooth boundary.

A13—24 to 37 inches; black (10YR 2/1) silty clay loam; weak medium prismatic structure parting to weak fine subangular blocky; friable; few fibrous roots; few fine dark accumulations of manganese and iron oxides; neutral; diffuse smooth boundary.

AC—37 to 51 inches; very dark gray (10YR 3/1) silty clay loam; few fine faint yellowish brown (10YR 5/4) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; neutral; clear smooth boundary.

Cg—51 to 60 inches; light brownish gray (2.5Y 6/2) silty clay loam; massive; friable; dark gray (10YR 4/1) clay films on vertical cleavage planes; slightly acid.

The solum ranges from 36 to 54 inches thick. The mollic epipedon is 36 or more inches thick.

The A horizon has hue of 10YR, 5Y, or is neutral; value of 2 or 3; and chroma of 0 or 1. The upper part of the A horizon ranges from silty clay loam to silt loam. Reaction ranges from neutral to medium acid.

Dickinson series

The Dickinson series consists of well drained and somewhat excessively drained soils on convex slopes on uplands and on convex dunes on stream benches. Permeability is moderately rapid and rapid. These soils formed in eolian sand or in sandy alluvium reworked by wind. Native vegetation was prairie grasses. Slope ranges from 2 to 14 percent.

Dickinson soils are similar to Saude and Sparta soils and are commonly adjacent to Clarion, Sparta, and Tama soils on the uplands; Sparta and Tama soils on loess-covered benches; and Nevin and Saude soils on stream benches. Saude soils have less than 50 percent fine sand and coarser in the upper part of the solum, have sand and gravel between a depth of 24 and 32 inches, and are in lower positions than Dickinson soils. Sparta soils have more sand and are lower in content of organic matter. Clarion soils are loam throughout the profile. They are in similar positions on the uplands. Nevin soils are silty and in lower positions. The Tama soils are silty throughout.

Typical pedon of Dickinson fine sandy loam, 5 to 9 percent slopes, 160 feet north and 1,700 feet east of the southwest corner of sec. 4, T. 84 N., R. 19 W.

Ap—0 to 5 inches; black (10YR 2/1) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine and very fine granular structure; friable; few fibrous roots; few worm channels; neutral; abrupt smooth boundary.

A12—5 to 11 inches; black (10YR 2/1) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure parting to weak fine and very fine granular; friable; few fibrous roots; few worm channels; strongly acid; gradual smooth boundary.

A13—11 to 18 inches; very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine and very fine subangular blocky structure; friable; few fibrous roots; few worm channels; medium acid; clear smooth boundary.

B1—18 to 24 inches; very dark grayish brown (10YR 3/2) fine sandy loam, very dark brown (10YR 2/2) faces on peds; weak fine and medium subangular blocky structure; friable; few fibrous roots; few worm channels; medium acid; clear smooth boundary.

B21—24 to 30 inches; brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) and very dark grayish brown (10YR 3/2) coatings on faces of peds; weak medium subangular blocky structure; friable; few fibrous roots; few worm channels; slightly acid; gradual smooth boundary.

B22—30 to 38 inches; brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) coatings on faces of peds; weak medium and coarse subangular blocky structure; friable; few fibrous roots; few worm channels; slightly acid; clear smooth boundary.

B3—38 to 45 inches; yellowish brown (10YR 5/4) loamy sand, brown (10YR 4/3) coatings on faces of peds; weak coarse subangular blocky structure; very friable; few fibrous roots; few worm channels; slightly acid; gradual smooth boundary.

C—45 to 60 inches; yellowish brown (10YR 5/4) loamy sand; massive; very friable; few worm channels; slightly acid.

The solum ranges from 24 to 50 inches in thickness.

The A horizon is 10 to 20 inches thick. It has value of 2 or 3 and chroma of 1 or 2. It is fine sandy loam, sandy loam, or loam. The B horizon ranges from very dark grayish brown (10YR 3/2) to brown (10YR 4/3) in the upper part and dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4 or 5/6) in the lower part. It is sandy loam or fine sandy loam in the upper part grading to loamy fine sand, loamy sand, fine sand, and sand in the lower part. Reaction is slightly acid to strongly acid. The C horizon is loamy fine sand, loamy sand, fine sand, or sand.

Dinsdale series

The Dinsdale series consists of well drained and moderately well drained soils on convex slopes on

uplands. Permeability is moderate. These soils formed in silty loess overlying glacial till. Native vegetation was prairie grasses. Slope ranges from 5 to 14 percent.

Dinsdale soils are similar to Tama and Wiota soils and are commonly adjacent to Liscomb and Tama soils. Liscomb soils are downslope or at a lower elevation than Dinsdale soils. They formed in friable glacial till or loamy surficial sediment overlying glacial till. Tama and Wiota soils formed in silty material. Tama soils are upslope or at a higher elevation. Wiota soils are on stream benches.

Typical pedon of Dinsdale silty clay loam, 5 to 9 percent slopes, 550 feet south and 310 feet west of the northeast corner of sec. 2, T. 85 N., R. 17 W.

Ap—0 to 8 inches; black (10YR 2/1) light silty clay loam, very dark grayish brown (10YR 3/2) dry; weak very fine granular structure; friable; few fibrous roots; few worm channels; medium acid; abrupt smooth boundary.

A12—8 to 14 inches; very dark brown (10YR 2/2) light silty clay loam, black (10YR 2/1) faces on peds, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak very fine granular; friable; few fibrous roots; few worm channels; medium acid; clear smooth boundary.

A3—14 to 18 inches; dark brown (10YR 3/3) light silty clay loam, very dark grayish brown (10YR 3/2) faces on peds, brown (10YR 4/3) dry; weak very fine subangular blocky structure parting to weak very fine granular; friable; few fibrous roots; few worm channels; medium acid; clear smooth boundary.

B21t—18 to 24 inches; brown (10YR 4/3) silty clay loam; weak medium prismatic structure parting to weak very fine subangular blocky; friable; few fibrous roots; few worm channels; thin discontinuous clay films; medium acid; gradual smooth boundary.

B22t—24 to 29 inches; brown (10YR 4/3) silty clay loam; weak medium prismatic structure parting to weak fine subangular blocky; friable; few fibrous roots; few worm channels; thin discontinuous clay films; medium acid; clear smooth boundary.

IIB31t—29 to 35 inches; dark yellowish brown (10YR 4/4) loam; weak medium prismatic structure parting to weak fine subangular blocky; firm; few fibrous roots; few worm channels; thin discontinuous clay films; few pebbles; slightly acid; gradual smooth boundary.

IIB32t—35 to 46 inches; dark yellowish brown (10YR 4/4) heavy loam; few fine distinct yellowish red (5YR 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; few fibrous roots; few worm channels; thin discontinuous clay films; few small pebbles; few small pockets of loamy sand; slightly acid; gradual smooth boundary.

IIB33—46 to 56 inches; yellowish brown (10YR 5/4) heavy loam; few fine faint yellowish brown (10YR 5/6) and few fine distinct yellowish red (5YR 5/6) mottles; weak coarse subangular blocky structure; firm; few fibrous roots; thin discontinuous clay films; few small pebbles; few small pockets of loamy sand; slightly acid; clear wavy boundary.

IIC—56 to 60 inches; yellowish brown (10YR 5/4) heavy loam; few fine faint yellowish brown (10YR 5/6) and few fine distinct yellowish red (5YR 5/6) mottles; massive; firm; few fibrous roots; few small pebbles; few small pockets and lenses of loamy sand; slight effervescence; neutral.

The solum ranges from 42 to 60 inches in thickness. The loess ranges from 18 to 42 inches thick.

The A horizon ranges from black (10YR 2/1) to dark brown (10YR 3/3). It ranges from 10 to 20 inches in thickness. The upper part of the B horizon has value of 3 or 4 and chroma of 3 or 4. Reaction is medium acid or strongly acid. The IIB horizon typically has matrix colors of yellowish brown in chroma of 4 through 8. It ranges from loam to light clay loam. In places, layers of sandy loam or loamy sand as much as 12 inches thick are between the upper part of the B horizon and the IIB or IIC horizons. The IIC horizon ranges from loam to clay loam.

The Dinsdale soils in map units 377C2 and 377D2 are taxadjuncts to the Dinsdale series because they do not have a mollic epipedon that is definitive for the Dinsdale series. These soils have an A horizon that ranges in thickness from 3 to 9 inches.

Downs series

The Downs series consists of well drained soils on convex ridgetops and side slopes in the uplands and on high stream benches. Permeability is moderate. These soils formed in silty loess under mixed grass and forest vegetation. Slope ranges from 2 to 18 percent.

Downs soils are similar to and commonly adjacent to Fayette and Tama soils. They are in similar positions. Fayette soils have a lighter colored surface layer. Tama soils have a darker surface layer.

Typical pedon of Downs silt loam, 2 to 5 percent slopes, 2,080 feet west and 1,080 feet north of the southeast corner of sec. 19, T. 82 N., R. 20 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; cloddy parting to weak fine subangular blocky structure; friable; common fibrous roots; medium acid; clear smooth boundary.

A2—8 to 12 inches; dark grayish brown (10YR 4/2) and brown (10YR 4/3) silt loam, light brownish gray and light gray (10YR 6/2 and 7/2) dry; moderate thin platy structure parting to weak very fine subangular blocky; friable; common fibrous roots; thin discontinuous light gray (10YR 7/2) dry silt coats; medium acid; clear smooth boundary.

B1—12 to 16 inches; dark yellowish brown (10YR 4/4) heavy silt loam; moderate very fine subangular

blocky structure; friable; thin discontinuous light gray (10YR 7/2) dry silt coats; few fibrous roots; medium acid; gradual smooth boundary.

B21t—16 to 22 inches; brown (10YR 5/3) silty clay loam, dark yellowish brown (10YR 4/4) coatings on peds; moderate very fine subangular blocky structure; friable; few fibrous roots; thin discontinuous clay films and light gray (10YR 7/2) dry silt coats; medium acid; clear smooth boundary.

B22t—22 to 36 inches; yellowish brown (10YR 5/4) silty clay loam; moderate and strong angular and subangular blocky structure; firm; few fibrous roots; thin discontinuous clay films and light gray (10YR 7/2) dry silt coats; strongly acid; gradual smooth boundary.

B3t—36 to 47 inches; yellowish brown (10YR 5/4) light silty clay loam; common fine distinct light brownish gray (2.5Y 6/2) and yellowish brown (10YR 5/6) mottles; weak prismatic structure parting to weak coarse subangular blocky; friable; few fibrous roots; thin discontinuous clay films and light gray (10YR 7/2) dry silt coats on prism faces; few fine dark accumulations of manganese and iron oxides; strongly acid; diffuse smooth boundary.

C—47 to 60 inches; mottled brown (10YR 5/3), light brownish gray (2.5Y 6/2), and strong brown (7.5YR 5/8) silty clay loam; some vertical cleavage; common fine dark accumulations of manganese and iron oxides; medium acid.

The solum ranges from 42 to 60 inches in thickness.

The A1 or Ap horizon typically ranges from 6 to 9 inches in thickness and is very dark brown (10YR 2/2) or dark grayish brown (10YR 3/2). The A2 horizon ranges from distinct to incipient and is mixed with the Ap horizon in many pedons. The upper part of the B horizon is commonly dark yellowish brown (10YR 4/4) that grades to value of 5 and chroma of 4 to 6 as depth increases.

Ely series

The Ely series consists of somewhat poorly drained soils on foot slopes. Permeability is moderate. These soils formed in silty local alluvium. Native vegetation was prairie grasses. Slope ranges from 2 to 5 percent.

Ely soils are similar to Judson soils and are commonly adjacent to Colo and Tama soils. Colo soils are on bottom lands. Colo soils have a thicker mollic epipedon and are downslope from Ely soils. They are poorly drained. Judson soils are well drained to moderately well drained and have browner B horizons. Tama soils are well drained, have a thinner A horizon, and are in higher positions on uplands.

Typical pedon of Ely silty clay loam, 2 to 5 percent slopes, 75 feet north and 2,510 feet east of the southwest corner of sec. 5, T. 83 N., R. 18 W.

Ap—0 to 9 inches; black (10YR 2/1) light silty clay loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; common fibrous roots; few worm channels; neutral; abrupt smooth boundary.

A12—9 to 16 inches; black (10YR 2/1) light silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; friable; common fibrous roots; few worm channels; slightly acid; gradual smooth boundary.

A3—16 to 26 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to moderate fine granular; friable; few fibrous roots; common worm channels; slightly acid; gradual smooth boundary.

B21—26 to 32 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) coatings on peds; moderate fine subangular blocky structure; friable; few fibrous roots; slightly acid; gradual smooth boundary.

B22—32 to 40 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine faint yellowish brown (10YR 5/6) and few medium faint grayish brown (10YR 5/2) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few fibrous roots; neutral; gradual smooth boundary.

B31—40 to 47 inches; grayish brown (2.5Y 5/2) light silty clay loam; few fine faint yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few fibrous roots; thin discontinuous clay films; few fine dark accumulations of manganese and iron oxides; neutral diffuse boundary.

B32—47 to 60 inches; light brownish gray (2.5Y 6/2) light silty clay loam; common fine faint yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; friable; few fine dark accumulations of manganese and iron oxides; neutral.

The solum ranges from 40 to 66 inches in thickness. The mollic epipedon ranges from 24 to 36 inches in thickness.

The A horizon is black (10YR 2/1), very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). It ranges from silt loam to silty clay loam. Reaction ranges from neutral to medium acid. The B horizon also ranges from neutral to medium acid.

Fayette series

The Fayette series consists of well drained soils on convex ridges and side slopes in the uplands. Permeability is moderate. These soils formed in silty loess. Native vegetation was deciduous trees. Slope ranges from 2 to 25 percent.

Fayette soils are similar to Downs and Tama soils and are commonly adjacent to Downs soils. All of these soils are in similar positions. Downs and Tama soils have a darker surface layer than Fayette soils. In addition,

Downs soils have a less distinct A2 horizon. Tama soils do not have an A2 horizon.

Typical pedon of Fayette silt loam, 2 to 5 percent slopes, 990 feet north and 2,600 feet east of the southwest corner of sec. 14, T. 85 N., R. 19 W.

A1—0 to 4 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; common fibrous roots; few worm channels; slightly acid; abrupt smooth boundary.

A21—4 to 8 inches; dark grayish brown (10YR 4/2) and brown (10YR 5/3) silt loam, pale brown (10YR 6/3) dry; moderate thin platy structure; friable; few worm channels; few fibrous roots; slightly acid; abrupt smooth boundary.

A22—8 to 11 inches; dark grayish brown (10YR 4/2) silt loam, pale brown (10YR 6/3) dry; moderate thick platy structure; friable; few fibrous roots; few worm channels; medium acid; abrupt smooth boundary.

B1—11 to 14 inches; dark yellowish brown (10YR 4/4) heavy silt loam, pale brown (10YR 6/3) dry; moderate very fine and fine subangular blocky structure; friable; few fibrous roots; thin discontinuous light gray (10YR 7/2) dry silt coats; medium acid; clear smooth boundary.

B21t—14 to 20 inches; dark yellowish brown (10YR 4/4) light silty clay loam; moderate fine angular and subangular blocky structure; friable; few fibrous roots; thin discontinuous dark grayish brown (10YR 4/2) clay films and light gray (10YR 7/2) dry silt coats; strongly acid; clear smooth boundary.

B22t—20 to 26 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate fine and medium angular blocky structure; friable; few fibrous roots; thin discontinuous dark yellowish brown (10YR 3/4) clay films and light gray (10YR 7/2) dry silt coats; strongly acid; clear smooth boundary.

B23t—26 to 38 inches; dark yellowish brown (10YR 4/4) light silty clay loam; few fine faint light olive brown (2.5Y 5/4) mottles; weak medium prismatic structure parting to weak coarse subangular blocky; friable; thin discontinuous dark yellowish brown (10YR 3/4) clay films and light gray (10YR 7/2) dry silt coats; strongly acid; gradual smooth boundary.

B3t—38 to 53 inches; yellowish brown (10YR 5/4) light silty clay loam; few fine faint light olive brown (2.5Y 5/4) mottles; weak coarse subangular blocky structure; friable; thin discontinuous dark yellowish brown (10YR 3/4) clay films; strongly acid; gradual smooth boundary.

C—53 to 60 inches; yellowish brown (10YR 5/4) silt loam; few fine faint grayish brown (10YR 5/2) and strong brown (7.5YR 5/8) mottles; massive; some vertical cleavage; friable; medium acid.

The solum ranges from 36 to 60 inches in thickness.

The A1 horizon ranges from 1 to 4 inches in thickness. It is very dark gray (10YR 3/1), very dark grayish brown (10YR 3/2), or very dark brown (10YR 2/2). The A2 horizon is dark grayish brown (10YR 4/2) or brown (10YR 4/3). The B2t horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4). Reaction is very strongly acid or strongly acid. The C horizon is silt loam or light silty clay loam.

Gara series

The Gara series consists of moderately well drained or well drained soils on side slopes on uplands. Permeability is moderately slow. These soils formed in clay loam glacial till of Kansan or Nebraskan age. Native vegetation was mixed deciduous trees and prairie grasses. Slope ranges from 14 to 25 percent.

Gara soils are similar to Lester, Lindley, and Shelby soils and are commonly adjacent to Downs and Lindley soils. Downs soils are silty and are on the shoulders and summits above the Gara soils. Lester soils have less clay in the B and C horizons, are less acid, and are not so deep to carbonates. Lindley soils are in positions similar to the Gara soils. Lindley soils have a thinner A1 horizon and a distinct A2 horizon with gray coatings on ped faces. The B horizons also have gray coatings on ped faces. Shelby soils have a mollic epipedon and do not have an A2 horizon.

Typical pedon of Gara loam, 14 to 18 percent slopes, 240 feet north and 1,820 feet east of the southwest corner of sec. 26, T. 83 N., R. 18 W.

A1—0 to 6 inches; very dark grayish brown (10YR 3/2) loam, light brownish gray (10YR 6/2) and gray (10YR 5/1) dry; weak very fine granular structure; friable; few fibrous roots; few pebbles; neutral; clear smooth boundary.

A2—6 to 11 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) coatings on peds; light brownish gray (10YR 6/2) and light gray (10YR 7/2) dry; weak medium platy structure parting to weak fine and medium subangular blocky; friable; few fibrous roots; few pebbles; medium acid; clear smooth boundary.

B21t—11 to 18 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) light clay loam, yellowish brown (10YR 5/4) and light yellowish brown (10YR 6/4) dry; moderate fine subangular blocky structure; firm; few fibrous roots; thin discontinuous brown (10YR 4/3) clay films; thin discontinuous pale brown (10YR 6/3) dry silt coats; few pebbles; medium acid; gradual smooth boundary.

B22t—18 to 25 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) clay loam; moderate fine and medium subangular blocky structure; firm; few fibrous roots; thin discontinuous brown (10YR 4/3) clay films; thin discontinuous pale brown (10YR 6/3) dry silt coats, few pebbles; strongly acid; gradual smooth boundary.

B23t—25 to 34 inches; yellowish brown (10YR 5/4) clay loam; few fine distinct strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; few fibrous roots; thin discontinuous brown (10YR 4/3) and dark yellowish brown (10YR 4/4) clay films; thin discontinuous light yellowish brown (10YR 6/4) dry silt coats; strongly acid; gradual smooth boundary.

B3t—34 to 47 inches; yellowish brown (10YR 5/4 and 5/6) clay loam; few fine distinct strong brown (7.5YR 5/6) and few fine and medium grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; thin discontinuous dark yellowish brown (10YR 4/4) clay films; few pebbles; few fine dark accumulations of manganese and iron oxides; medium acid; gradual smooth boundary.

C1—47 to 51 inches; mottled yellowish brown (10YR 5/4) and grayish brown (2.5Y 5/2) clay loam; massive; firm; few pebbles; few fine dark accumulations of manganese and iron oxides; mildly alkaline; gradual smooth boundary.

C2—51 to 60 inches; yellowish brown (10YR 5/4) and grayish brown (2.5Y 5/2) clay loam; massive; firm; few pebbles; few fine dark accumulations of manganese and iron oxides; few soft calcium carbonate accumulations; strong effervescence; mildly alkaline.

The solum ranges from 36 to more than 60 inches in thickness. The thickness of the solum and depth to carbonates are generally the same.

The A1 horizon ranges from 6 to 9 inches in thickness. It is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The B2t horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 through 6.

Garwin series

The Garwin series consists of poorly drained soils on loess-mantled divides and at the heads of drains on uplands. Permeability is moderate. These soils formed in loess. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Garwin soils are similar to Muscatine soils and are commonly adjacent to Harpster, Muscatine, and Tama soils. Harpster soils are in depressions. Muscatine and Tama soils are on higher lying areas. Harpster soils are calcareous throughout the solum. Muscatine soils are somewhat poorly drained and have higher chroma in the B horizon. Tama soils are well drained. They have thinner A horizons and browner B horizons.

Typical pedon of Garwin silty clay loam, 0 to 2 percent slopes, 280 feet west and 2,340 feet north of the southeast corner of sec. 10, T. 85 N., R. 17 W.

A11—0 to 8 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; moderate fine and medium granular structure; friable; neutral; clear smooth boundary.

A12—8 to 13 inches; black (10YR 2/1) silty clay loam, black (N 2/0) coatings on peds, very dark gray (10YR 3/1) dry; moderate fine granular structure; friable; neutral; clear smooth boundary.

A3—13 to 17 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) coatings on peds, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure parting to moderate fine granular; friable; neutral; clear smooth boundary.

B1g—17 to 21 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) coatings on peds; moderate fine subangular blocky structure; friable; neutral; clear smooth boundary.

B21g—21 to 30 inches; gray (5Y 5/1) silty clay loam, few fine faint grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure; friable; neutral; diffuse smooth boundary.

B22g—30 to 37 inches; olive gray (5Y 5/2) silty clay loam; few fine prominent yellowish brown (10YR 5/6 and 5/8) and strong brown (7.5YR 5/6 and 5/8) mottles; weak medium subangular blocky structure; friable; few fine dark accumulations of manganese and iron oxides; neutral; clear smooth boundary.

B3g—37 to 48 inches; light olive gray (5Y 6/2) light silty clay loam; common fine distinct strong brown (7.5YR 5/6 and 5/8) mottles; weak medium subangular blocky structure; friable; few fine dark accumulations of manganese and iron oxides; neutral; clear smooth boundary.

Cg—48 to 60 inches; light olive gray (5Y 6/2) light silty clay loam; common medium prominent yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6 and 5/8) mottles; massive; friable; neutral; slight effervesence.

The solum ranges from 40 to 60 inches in thickness.

The A1 horizon is black (10YR 2/1, N 2/0). It is 10 to 17 inches thick and ranges from neutral to medium acid. The B2 horizon is dark gray (N 4/0, 5Y 4/1). The B2 horizon is 10 to 22 inches thick and is neutral or slightly acid. The C horizon ranges from dark gray (5Y 4/1) to light olive gray (5Y 6/2). The C horizon is silty clay loam or silt loam and is neutral or mildly alkaline.

Hanlon series

The Hanlon series consists of moderately well drained soils on natural levees and bottom lands. Permeability is moderately rapid. These soils formed in loamy and sandy alluvium. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Hanlon soils are similar to Dickinson soils and are commonly adjacent to Colo and Lawson soils. Dickinson soils have a thinner A horizon. Colo and Lawson soils are silty. Colo soils are poorly drained and are on lower lying flood plains some distance from the channel. Lawson soils are somewhat poorly drained. They are closely associated with Hanlon soils near the channel.

Typical pedon of Hanlon fine sandy loam, 0 to 2 percent slopes, 1,120 feet north and 440 feet east of the southwest corner of sec. 1, T. 84 N., R. 19 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; few fibrous roots; slightly acid; clear smooth boundary.

A12—8 to 16 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; few fibrous roots; neutral; clear smooth boundary.

A13—16 to 31 inches; very dark grayish brown (10YR 3/2) and some dark grayish brown (10YR 4/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; friable; few fibrous roots; neutral; gradual smooth boundary.

B2—31 to 40 inches; very dark grayish brown (10YR 3/2) fine sandy loam mixed with some very dark gray (10YR 3/1); weak medium subangular blocky structure; friable; few fibrous roots; neutral; clear smooth boundary.

C1—40 to 47 inches; dark grayish brown (10YR 4/2) loamy fine sand; grayish brown (10YR 5/2) and very dark grayish brown (10YR 3/2) strata; massive; very friable; neutral; gradual smooth boundary.

C2—47 to 60 inches; stratified, very dark grayish brown (10YR 3/2), dark grayish brown (10YR 4/2), and grayish brown (10YR 5/2) fine sandy loam; massive; friable; neutral.

The solum ranges from 40 to 72 inches in thickness. No free carbonates are present to a depth of 4 feet or more. The mollic epipedon is typically 40 to 70 inches thick. The 10- to 40-inch control section averages 12 to 18 percent clay and 50 to 75 percent sand.

Hanska series

The Hanska series consists of poorly drained soils on low stream benches. Permeability is moderately rapid in the solum and rapid in the substratum. These soils formed in loamy alluvium over sand. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Hanska soils are similar to Canisteo soils and are commonly adjacent to Coland, Lawler, Saude, Waukee, and Zook soils. Canisteo soils do not have coarse textured material in the C horizon. Lawler, Saude, and Waukee soils are on slightly higher areas on stream benches. The somewhat poorly drained Lawler and the well drained Saude and Waukee soils have less clay in the solum than Hanska soils. Coland and Zook soils are on flood plains near the bench escarpments. They have a mollic epipedon more than 36 inches thick and have more clay in the solum.

Typical pedon of Hanska loam, 0 to 2 percent slopes, 2,100 feet south and 540 feet east of the northwest corner of sec. 15, T. 85 N., R. 19 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; few fibrous roots; few worm channels; neutral; abrupt smooth boundary.

A12—7 to 13 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; common fine faint very dark gray (10YR 3/1) mottles; weak very fine subangular blocky strucuture; friable; few fibrous roots; few worm channels; neutral; gradual smooth boundary.

B21g—13 to 18 inches; dark gray (5Y 4/1) sandy loam, very dark gray (10YR 3/1) coatings on peds; few medium faint grayish brown (2.5Y 5/2) and few fine distinct brown (10YR 5/3) mottles; weak medium prismatic structure parting to weak fine subangular blocky; friable; few fibrous roots; few worm channels; neutral; gradual smooth boundary.

B22g—18 to 24 inches; gray (5Y 5/1) sandy loam; few fine faint light gray (5Y 6/1), common medium faint grayish brown (2.5Y 5/2), and common fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium prismatic structure parting to weak fine subangular blocky; friable; few fibrous roots; neutral; clear smooth boundary.

B31g—24 to 29 inches; grayish brown (2.5Y 5/2) sandy loam; few fine faint strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; few fibrous roots; neutral; clear smooth boundary.

B32g—29 to 34 inches; grayish brown (2.5Y 5/2) sandy loam; common medium faint strong brown (7.5YR 5/6) and few medium distinct yellowish red (5YR 4/6) mottles; weak coarse subangular blocky structure; friable; few fibrous roots; neutral; abrupt smooth boundary.

IIC1—34 to 44 inches; light brownish gray (2.5Y 6/2) sand; few fine distinct strong brown (7.5YR 5/6) mottles; single grain; loose; few pebbles; neutral; gradual smooth boundary.

IIC2—44 to 60 inches; light brownish gray (2.5Y 6/2) coarse sand; few fine distinct strong brown (7.5YR 5/6) mottles; single grain; loose; few pebbles; neutral.

The solum ranges from 24 to 40 inches in thickness. The mollic epipedon ranges from 12 to 24 inches in thickness. Depth to sand ranges from 32 to 40 inches.

The A horizon has hue of 10YR, 2.5Y, or is neutral and has value of 2 or 3. Reaction is neutral to medium acid. The IIC horizon is sand or coarse sand.

Harps series

The Harps series consists of poorly drained soils on the rims of depressions and upland flats of glacial till or outwash plains. Permeability is moderate. These soils formed in loam glacial till or in alluvium derived from till. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Harps soils are similar to Canisteo and Harpster soils and are commonly adjacent to Canisteo, Nicollet, Okoboji, and Webster soils. Canisteo soils have lower calcium carbonate equivalents in the solum and have a slightly lower sand content than Harps soils. Harpster soils are silty. Nicollet and Webster soils are noncalcareous and are somewhat poorly drained and poorly drained. These soils are in low lying areas near the Harps soils. The very poorly drained Okoboji soils are noncalcareous and are in depressional areas.

Typical pedon of Harps loam, 0 to 2 percent slopes, 2,210 feet north and 1,430 feet west of the southeast corner of sec. 18, T. 83 N., R. 20 W.

Apca—0 to 6 inches; black (10YR 2/1) heavy loam, gray (10YR 5/1) dry; weak very fine granular structure; friable; few worm channels; few fibrous roots; few pebbles; few snail shells; violent effervescence (40 percent calcium carbonate); moderately alkaline; abrupt smooth boundary.

A12ca—6 to 11 inches; very dark gray (10YR 3/1) light clay loam, gray (10YR 5/1) dry; few fine faint dark grayish brown (2.5Y 4.2) mottles; weak fine granular structure; friable; few fibrous roots; few worm channels; few pebbles; few snail shells; violent effervescence; (30 percent calcium carbonate) moderately alkaline; clear smooth boundary.

A3ca—11 to 18 inches; very dark gray (10YR 3/1) heavy loam, dark gray (10YR 4/1) and gray (10YR 5/1) dry; few fine faint dark grayish brown (2.5Y 4/2) mottles; weak very fine subangular blocky structure; friable; few fibrous roots; few worm channels; few pebbles; few snail shells; violent effervescence (20 percent calcium carbonate); moderately alkaline; diffuse wavy boundary.

B1gca—18 to 28 inches; olive gray (5Y 5/2) and light brownish gray (2.5Y 6/2) loam; few fine prominent yellowish brown (10YR 5/8) mottles; weak fine subangular blocky structure; friable; few fibrous roots; many very dark gray (10YR 3/1) and dark gray (10YR 4/1) krotovinas; few worm channels; few pebbles; few fine carbonate concretions; violent effervescence (20 percent calcium carbonate); moderately alkaline; gradual smooth boundary.

B2g—28 to 37 inches; olive gray (5Y 5/2) and light olive gray (5Y 6/2) loam; common fine prominent yellowish brown (10YR 5/8) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few fibrous roots; few worm channels; few pebbles; few fine dark accumulations of manganese and iron oxides; few fine carbonate concretions; strong effervescence (18 percent calcium carbonate); moderately alkaline; gradual smooth boundary.

B23g—37 to 43 inches; grayish brown (2.5Y 5/2) loam; common fine prominent yellowish brown (10YR 5/6) mottles; weak medium prismatic structure; friable; few pebbles; few fine dark accumulations of manganese and iron oxides; strong effervescence (18 percent calcium carbonate); moderately alkaline; gradual smooth boundary.

Cg—43 to 60 inches; grayish brown (2.5Y 5/2) loam; common fine prominent yellowish brown (10YR 5/6) mottles; massive; friable; few pebbles; few fine dark accumulations of manganese and iron oxides; few coarse carbonate concretions; strong effervescence (19 percent calcium carbonate); moderately alkaline.

The solum is typically 30 to 50 inches thick. The mollic epipedon ranges from 10 to 21 inches in thickness. The calcic horizon is typically 16 to 31 inches thick, and the upper part is 15 to 40 percent calcium carbonate equivalent. The B horizon is loam, clay loam, or sandy clay loam that is 18 to 30 percent clay.

Harpster series

The Harpster series consists of poorly drained soils on loess-mantled divides and at the heads of upland drains. Permeability is moderate. These soils formed in silty, calcareous loess. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Harpster soils are similar to Harps soils and are commonly adjacent to Garwin and Muscatine soils. Muscatine and Garwin soils are on higher lying areas than Harpster soils. Garwin soils are neutral to medium acid. Harps soils are more than 15 percent fine and coarser sand. Muscatine soils are somewhat poorly drained and have browner B horizons.

Typical pedon of Harpster silty clay loam, 0 to 2 percent slopes, 2,100 feet south and 420 feet east of the northwest corner of sec. 18, T. 85 N., R. 18 W.

Apca—0 to 8 inches; black (10YR 2/1) light silty clay loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; common fibrous roots; few snail shells; strong effervescence (22 percent calcium carbonate); mildly alkaline; abrupt smooth boundary.

A12ca—8 to 15 inches; black (10YR 2/1) light silty clay loam, very dark gray (10YR 3/1) dry; few medium distinct dark gray (5Y 4/1) mottles; moderate fine granular structure; friable; common fibrous roots; few snail shells; strong effervescence (25 percent calcium carbonate); mildly alkaline; gradual smooth boundary.

A3ca—15 to 20 inches; very dark gray (10YR 3/1) light silty clay loam, dark gray (10YR 4/1) dry; few medium distinct dark gray (5Y 4/1) mottles; weak very fine subangular blocky structure; friable; few fibrous roots; strong effervescence (18 percent calcium carbonate); mildly alkaline; clear smooth boundary.

B1gca—20 to 25 inches; dark gray (5Y 4/1) light silty clay loam; common medium distinct olive brown (2.5Y 4/4) mottles; weak fine subangular blocky

structure; friable; few fibrous roots; few worm channels; few coarse very dark gray (10YR 3/1) krotovina; strong effervescence (15 percent calcium carbonate); mildly alkaline; gradual smooth boundary.

B21g—25 to 32 inches; olive gray (5Y 5/2) and light olive gray (5Y 6/2) light silty clay loam; few medium prominent yellowish brown (10YR 5/8) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few fibrous roots; few worm channels; few fine carbonate concretions; slight effervescence; mildly alkaline; clear smooth boundary.

B22g—32 to 38 inches; olive gray (5Y 5/2) and light olive gray (5Y 6/2) light silty clay loam; common medium prominent strong brown (7.5YR 5/8) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few fibrous roots; few worm channels; few medium very dark gray (10YR 3/1) krotovina; slight effervescence; mildly alkaline; gradual smooth boundary.

B3—38 to 42 inches; light olive gray (5Y 6/2) light silty clay loam; many medium prominent strong brown (7.5YR 5/8) mottles; weak coarse subangular blocky structure; friable; few fibrous roots; few worm channels; few medium very dark gray (10YR 3/1) krotovina; slight effervescence; mildly alkaline; gradual smooth boundary.

Cg—42 to 50 inches; light gray (5Y 6/1) heavy silt loam; common medium prominent strong brown (7.5YR 5/8) mottles; massive; friable; few worm channels; few coarse very dark gray (10YR 3/1) krotovina; few fine carbonate concretions; few snail shells; slight effervescence; neutral; gradual smooth boundary.

C2--50 to 60 inches; light gray (5Y 6/1) heavy silt loam; common coarse prominent strong brown (7.5YR 5/8) mottles; massive; friable; few coarse very dark gray (10YR 3/1) krotovina; few fine dark accumulations of manganese and iron oxides; slight effervescence; neutral.

The solum ranges from 24 to 45 inches in thickness. The mollic epipedon ranges from 10 to 24 inches in thickness.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 0 through 2. It ranges from silt loam to silty clay loam. The calcic horizon is 15 to 30 percent calcium carbonate equivalent. The Bg horizon has hue of 10YR through 5Y, value of 4 or more, and chroma of 2 or less.

Judson series

The Judson series consists of well drained or moderately well drained soils on foot slopes. Permeability is moderate. These soils formed in silty sediment eroded from adjacent uplands. Native vegetation was prairie grasses. Slope ranges from 2 to 9 percent.

Judson soils are similar to Ely soils and are commonly adjacent to Colo and Tama soils. Colo soils have a thicker mollic epipedon and are on bottom lands. Ely soils are somewhat poorly drained and have lower chroma in the B horizon. Tama soils have thinner A horizons, more strongly expressed B horizons, and are on convex slopes on uplands.

Typical pedon of Judson silty clay loam, 2 to 5 percent slopes, 1,180 feet north and 3,560 feet east of the southwest corner of sec. 33, T. 85 N., R., 17 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) light silty clay loam, very dark brown (10YR 2/2) coatings on peds, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; friable; common fibrous roots; slightly acid; abrupt smooth boundary.

A12—8 to 16 inches; very dark grayish brown (10YR 3/2) light silty clay loam, very dark brown (10YR 2/2) coatings on peds, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; friable; few fibrous roots; neutral; clear smooth boundary.

A13—16 to 26 inches; very dark brown (10YR 2/2) silty clay loam, black (10YR 2/1) coatings on peds, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure parting to weak fine granular; friable; few fibrous roots; slightly acid; gradual smooth boundary.

A3—26 to 34 inches; very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; friable; few fibrous roots; slightly acid; clear smooth boundary.

B2—34 to 42 inches; dark brown (10YR 3/3) silty clay loam; moderate fine subangular blocky structure; friable; few fibrous roots; slightly acid; gradual smooth boundary.

B3—42 to 60 inches; dark yellowish brown (10YR 4/4) silty clay loam; weak medium prismatic structure parting to weak medium subangular blocky; friable; few fibrous roots; slightly acid.

The solum ranges from 40 to 70 inches in thickness. The A horizon is 24 to 36 inches thick. It ranges from black (10YR 2/1) and very dark grayish brown (10YR 3/2) in the upper part to dark brown (10YR 3/3) in the lower part. Reaction ranges from neutral to medium acid. The B horizon has value of 3 or 4 and chroma of 3 or 4 Reaction is slightly acid or medium acid.

Killduff series

The Killduff series consists of well drained or moderately well drained soils on upland coves. Permeability is moderate. These soils formed in loess that is partly deoxidized and leached. Native vegetation was prairie grasses. Slope ranges from 5 to 18 percent.

Killduff soils are similar to Downs and Tama soils and are adjacent to Tama soils. Downs soils do not have grayish brown mottles above a depth of 30 inches. Tama soils have a mollic epipedon and are deeper to grayish brown mottles. Downs and Tama soils also have argillic horizons. Tama soils are upslope or at a higher elevation than Killduff soils.

Typical pedon of Killduff silty clay loam, 5 to 9 percent slopes, moderately eroded, 140 feet north and 2,360 feet east of the southwest corner of sec. 31, T. 82 N., R. 17 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silty clay loam with some mixing of brown (10YR 4/3), grayish brown (10YR 5/2) dry; weak very fine granular structure; friable; slightly acid; abrupt smooth boundary.

B1—7 to 12 inches; brown (10YR 4/3) silty clay loam, some dark brown (10YR 3/3) coatings on peds; weak very fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B21—12 to 18 inches; brown (10YR 5/3) silty clay loam, some brown (10YR 4/3) coatings on peds; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B22—18 to 24 inches; brown (10YR 5/3) silty clay loam; common fine faint grayish brown (2.5Y 5/2) mottles; some brown (10YR 4/3) coatings on peds; weak fine and medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B23—24 to 30 inches; grayish brown (2.5Y 5/2) light silty clay loam; common yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; few fine dark accumulations of manganese and iron oxides; slightly acid; gradual smooth boundary.

B3—30 to 38 inches; light brownish gray (2.5Y 6/2) light silty clay loam; common medium distinct strong brown (7.5YR 5/6) mottles; some brown (10YR 4/3) faces of prisms; massive; friable; few fine dark accumulations of manganese and iron oxides; slightly acid; gradual smooth boundary.

C—38 to 60 inches; light brownish gray (2.5Y 6/2) heavy silt loam; common medium distinct yellowish brown (10YR 5/6) and common fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; few fine dark accumulations of manganese and iron oxides; few fine carbonate concretions; slight effervescence; moderately alkaline.

The solum is typically 36 to 48 inches thick but ranges from 32 to 55 inches. No carbonates are above a depth of 35 inches. The mollic epipedon is less than 10 inches thick.

The A1 or Ap horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2). The A3 horizon, where present, is very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3). The B1 horizon is typically dark brown (10YR 3/3) or brown (10YR 4/3). The B3 and C horizons are silty clay loam or silt loam.

Koszta series

The Koszta series consists of somewhat poorly drained soils on low stream benches or second bottoms. Permeability is moderate. These soils formed in silty alluvium. Native vegetation was mixed deciduous trees and grasses. Slope ranges from 1 to 3 percent.

Koszta soils are similar to Nevin soils and are commonly adjacent to Bremer, Colo, and Wiota soils. Nevin soils have a darker surface and subsurface layer. They do not have an A2 horizon. Bremer and Wiota soils are in similar positions. Bremer soils are poorly drained and higher in clay. Colo soils have a thicker subsurface layer and are on bottom lands. Wiota soils have a thicker A1 horizon and do not have an A2 horizon. They have higher chroma and do not have mottles in the upper part of the B horizon.

Typical pedon of Koszta silt loam, 1 to 3 percent slopes, 42 feet north and 670 feet east of southwest corner of sec. 13, T. 84 N., R. 18 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) silt loam, very dark grayish brown (10YR 3/2) kneaded, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few fibrous roots; slightly acid; abrupt smooth boundary.

A2—8 to 14 inches; dark grayish brown (10YR 4/2) silt loam mixed with some grayish brown (10YR 5/2), dark grayish brown (10YR 4/2) kneaded, light gray (10YR 7/2) dry; weak thin platy structure parting to weak fine granular; friable; few fibrous roots; slightly acid; clear smooth boundary.

B1—14 to 21 inches; brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) coatings on peds; weak medium prismatic structure parting to moderate fine and medium subangular blocky; friable; few fibrous roots; thin discontinuous grayish brown (10YR 5/2) silt coats; strongly acid; gradual smooth boundary.

B21t—21 to 30 inches; brown (10YR 5/3) silty clay loam; few fine faint grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate fine and medium angular blocky; firm; thin discontinuous clay films; thin discontinuous grayish brown (10YR 5/2) silt coats; few fibrous roots; strongly acid; gradual smooth boundary.

B22t—30 to 40 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine faint yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate fine and medium angular blocky; firm; few fibrous roots; thin discontinuous clay films; thin discontinuous grayish brown (10YR 5/2) silt coats; few fine dark accumulations of manganese and iron oxides; medium acid; gradual smooth boundary.

B3t—40 to 50 inches; mottled light gray (5Y 6/1) and yellowish brown (10YR 5/4, 5/6) silty clay loam; weak coarse prismatic structure parting to moderate medium subangular blocky; firm; very dark gray (10YR 3/1) root channels; thin discontinuous clay films; few fine dark accumulations of manganese and iron oxides; medium acid; gradual smooth boundary.

C—50 to 60 inches; mottled light gray (5Y 6/1) and yellowish brown (10YR 5/4, 5/6) silty clay loam; massive with some vertical cleavage; firm; few fine dark accumulations of manganese and iron oxides; slightly acid.

The solum ranges from 36 to 60 inches in thickness. The A1 or Ap horizon is black (10YR 2/1), very dark grayish brown (10YR 2/2), or very dark gray (10YR 3/1). The A2 horizon is typically dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2). The B horizon ranges from dark grayish brown (10YR 4/2) to grayish brown (2.5Y 5/2), gray (5Y 5/1), light gray (5Y 6/1), olive gray (5Y 5/2), and yellowish brown (10YR 5/4, 5/6, 5/8). The B2 horizon averages 28 to 35 percent clay.

Lawler series

The Lawler series consists of somewhat poorly drained soils on stream benches and outwash plains. Permeability is moderate in the upper part and rapid in the lower part. These soils formed in about 32 to 40 inches of loamy alluvium underlain by sand and gravel. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Lawler soils are similar to and commonly adjacent to Hanska, Saude, and Waukee soils. Hanska soils are better drained, have grayer B horizons, and are on lower lying, nearly level slopes. Saude and Waukee soils have browner B horizons that do not have mottles in chroma of 2 and are on more sloping areas. Saude soils are less deep to contrasting textures.

Typical pedon of Lawler loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, 168 feet east and 115 feet north of the center of sec. 15, T. 85 N., R. 19 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak very fine granular structure; friable; few fibrous roots; few worm channels; slightly acid; abrupt smooth boundary.

A12—6 to 11 inches; very dark gray (10YR 3/1) loam, dark grayish brown (10YR 4/2) dry; few fine distinct dark brown (7.5YR 3/3) mottles; weak fine granular structure; friable; few fibrous roots; few worm channels; neutral; gradual smooth boundary.

A3—11 to 16 inches; very dark grayish brown (10YR 3/2) light loam, very dark gray (10YR 3/1) coatings on peds, dark grayish brown (10YR 4/2) dry; few fine distinct strong brown (7.5YR 5/6) mottles; weak very fine subangular blocky structure; friable; few fibrous roots; few worm channels; neutral; gradual smooth boundary.

B21—16 to 21 inches; dark grayish brown (10YR 4/2) light sandy clay loam, very dark gray (10YR 3/1) coatings on peds; few fine faint very dark grayish brown (10YR 3/2), brown (10YR 4/3), and strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; few fibrous roots; few worm channels; neutral; gradual smooth boundary.

B22—21 to 27 inches; dark grayish brown (10YR 4/2) light sandy clay loam; few fine faint yellowish brown (10YR 5/4) and strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; few fibrous roots; few pebbles; slightly acid; gradual smooth boundary.

B23—27 to 32 inches; grayish brown (2.5Y 5/2) light sandy clay loam; few medium faint yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; slightly sticky; few pebbles; neutral; clear smooth boundary.

IIB3—32 to 36 inches; grayish brown (2.5Y 5/2) loamy sand; few medium faint brown (7.5YR 5/4) mottles; weak coarse subangular blocky structure; loose; few pebbles; neutral; gradual smooth boundary.

IIC1—36 to 55 inches; brown (10YR 5/3) and grayish brown (2.5Y 5/2) loamy sand; common medium distinct strong brown (7.5YR 4/6) and few medium faint brown (10YR 4/3) mottles; massive; loose; few pebbles; neutral; clear smooth boundary.

IIC2—55 to 60 inches; grayish brown (10YR 5/2) sand; common medium faint strong brown (7.5YR 5/6) mottles; single grain; loose; slightly acid.

The solum ranges from 24 to 40 inches in thickness. Depth to sandy or gravelly material ranges from 32 to 40 inches.

The A horizon ranges from 12 to 24 inches in thickness. It is loam or silt loam and is high in content of sand. The B2 horizon is neutral to medium acid. Typically, it is mottled dark grayish brown (10YR or 2.5Y 4/2), grayish brown (2.5Y 5/2), or olive brown (2.5Y 4/4) sandy clay loam that ranges from loam to light clay loam. Typically, the C horizon ranges from loamy sand to gravelly loamy sand.

Lawson series

The Lawson series consists of somewhat poorly drained soils on first and second bottoms near major streams. Permeability is moderate. These soils formed in silty alluvium. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Lawson soils are similar to Colo, Ely, and Zook soils and are commonly adjacent to Colo, Lawler, Nodaway, and Zook soils. Colo soils have a mollic epipedon 36 inches or more thick, are poorly drained, and occupy the lower parts of first and second bottoms. Ely soils have

cambic horizons and are on foot slopes. Lawler soils have more sand throughout and are on low stream benches or second bottoms. Nodaway soils do not have a mollic epipedon and are closer to the stream channel than Lawson soils. The poorly drained Zook soils are finer textured and are on the lower parts of first bottoms.

Typical pedon of Lawson silty clay loam, 0 to 2 percent slopes, 1,700 feet west and 220 feet south of the northeast corner of sec. 32, T. 84 N., R. 17 W.

Ap—0 to 6 inches; black (10YR 2/1) light silty clay loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; friable; common fibrous roots; neutral; abrupt smooth boundary.

A12—6 to 11 inches; black (10YR 2/1) light silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; common fibrous roots; neutral; gradual smooth boundary.

A13—11 to 18 inches; very dark brown (10YR 2/2) light silty clay loam, some black (10YR 2/1) coatings on peds, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; few fibrous roots; neutral; gradual smooth boundary.

A14—18 to 30 inches; very dark grayish brown (10YR 3/2) light silty clay loam, very dark gray (10YR 3/1) coatings on peds, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; few fibrous roots; slightly acid; gradual smooth boundary.

C1—30 to 40 inches; grayish brown (2.5Y 5/2) light silty clay loam; few fine faint strong brown (7.5YR 4/6) mottles; weak medium subangular blocky structure; friable; few fibrous roots; few soft dark accumulations of manganese and iron oxides; slightly acid; gradual smooth boundary.

C2—40 to 50 inches; dark grayish brown (2.5Y 4/2) light silty clay loam; few fine faint grayish brown (2.5Y 5/2) and few fine distinct strong brown (7.5YR 4/6) mottles; massive; friable; few fibrous roots; few soft dark accumulations of manganese and iron oxides; slightly acid; gradual smooth boundary.

C3—50 to 60 inches; dark grayish brown (2.5Y 4/2) light silty clay loam; few fine distinct yellowish brown (10YR 5/6), strong brown (7.5YR 4/6), and few fine faint grayish brown (2.5Y 5/2) mottles; massive; friable; few fibrous roots; few soft dark accumulations of manganese and iron oxides; slightly acid.

The Lawson soils are silt loam or silty clay loam to a depth of 40 inches or more. The mollic epipedon ranges from 24 to 36 inches in thickness. The 10- to 40-inch control section averages 24 to 30 percent clay and ranges from slightly acid to neutral.

Lester series

The Lester series consists of well drained soils on convex slopes of glacial ground or terminal moraines. Permeability is moderate. These soils formed in calcareous, loam glacial till of Late Wisconsin age. Native vegetation was mixed deciduous trees and prairie grasses. Slope ranges from 5 to 25 percent.

Lester soils are similar to Gara soils and are commonly adjacent to Clarion soils. Gara soils have a firmer, finer textured B horizon and formed in Kansan till. Clarion soils have a thicker A horizon and are in positions similar to Lester soils.

Typical pedon of Lester loam, 18 to 25 percent slopes, 900 feet west and 500 feet north of the center of sec. 18, T. 82 N., R. 20 W.

A1—0 to 5 inches; very dark gray (10YR 3/1) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; common fibrous roots; few pebbles; slightly acid; clear smooth boundary.

A2—5 to 9 inches; dark grayish brown (10YR 4/2) loam with some very dark grayish brown (10YR 3/2) coatings on peds, light brownish gray (10YR 6/2) dry; weak thin platy structure parting to weak fine subangular blocky; friable; common fibrous roots; few pebbles; slightly acid; clear smooth boundary.

B1—9 to 14 inches; brown (10YR 4/3) light clay loam mixed with some very dark grayish brown (10YR 3/2); moderate fine subangular blocky structure; firm; common fibrous roots; thin discontinuous grayish brown (10YR 5/2) silt coats; few pebbles; medium acid; gradual smooth boundary.

B21t—14 to 20 inches; brown (10YR 4/3) clay loam; moderate fine angular and subangular blocky structure; firm; few fibrous roots; thin discontinuous clay films and grayish brown (10YR 5/2) silt coats; few pebbles; strongly acid; gradual smooth boundary.

B22t—20 to 34 inches; dark yellowish brown (10YR 4/4) clay loam; weak medium prismatic structure parting to moderate angular and subangular blocky; firm; few fibrous roots; thin discontinuous clay films and grayish brown (10YR 5/2) silt coats; few pebbles; strongly acid; gradual smooth boundary.

B3t—34 to 42 inches; yellowish brown (10YR 5/4) light clay loam; weak medium prismatic structure parting to weak medium subangular blocky; firm; few pebbles; thin discontinuous clay films; slightly acid; abrupt wavy boundary.

C—42 to 60 inches; yellowish brown (10YR 5/4) loam; few fine faint yellowish brown (10YR 5/5), strong brown (7.5YR 4/6), and light brownish gray (2.5Y 6/2) mottles; massive; friable; few pebbles; strong effervescence; mildly alkaline.

The solum ranges from 30 to 48 inches in thickness. The A1 horizon has hue of 10YR, value of 2 or 3, and

chroma of 1 or 2. The A2 horizon has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. The A horizon is loam or light clay loam. The upper part of the B horizon has hue of 10YR, value of 4, and chroma of 3 or 4. The lower part has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 or 4. The B horizon is clay loam and ranges from slightly acid to strongly acid. The C horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 3 through 6.

Lindley series

The Lindley series consists of well drained soils on side slopes on uplands. Permeability is moderately slow. These soils formed in loamy glacial till of Kansan and Nebraskan age. Native vegetation was deciduous trees. Slope ranges from 18 to 40 percent.

Lindley soils are similar to Lester soils and are commonly adjacent to Downs, Fayette, and Gara soils. Lester soils have thicker A horizons and more friable B horizons. Downs and Gara soils have thicker, dark A horizons. Downs and Fayette soils are fine-silty and formed in loess. Downs and Fayette soils are higher than Lindley soils on the side slopes. Gara soils are in positions similar to Lindley soils.

Typical pedon of Lindley loam, 18 to 25 percent slopes, 160 feet west and 300 feet north of the center of sec. 25, T. 83 N., R. 18 W.

A1—0 to 3 inches; very dark gray (10YR 3/1) light loam, dark gray (10YR 4/1) and grayish brown (10YR 5/2) dry; weak fine granular structure; friable; few fibrous roots; strongly acid; abrupt smooth boundary.

A2—3 to 7 inches; dark grayish brown (10YR 4/2) light loam, light gray (10YR 7/2) dry; moderate thin platy structure; friable; few fibrous roots; strongly acid; clear smooth boundary.

B1t—7 to 11 inches; brown (10YR 4/3) loam, dark grayish brown (10YR 4/2) coatings on peds; moderate fine subangular structure; friable; thin discontinuous clay films; thin discontinuous light gray (10YR 7/2) silt coats; few fibrous roots; strongly acid; clear smooth boundary.

B21t—11 to 19 inches; strong brown (7.5YR 5/6) heavy loam, brown (7.5YR 4/4) coatings on peds; moderate fine subangular and angular blocky structure; friable; thin discontinuous clay films; thin discontinuous light gray (10YR 7/2) silt coats; few fibrous roots; strongly acid; gradual smooth boundary.

B22t—19 to 34 inches; strong brown (7.5YR 5/6) clay loam, brown (7.5YR 4/4) coatings on peds; moderate fine angular blocky structure; firm; thin discontinuous clay films; thin discontinuous light gray (10YR 7/2) silt coats; medium acid; gradual smooth boundary.

B23t—34 to 50 inches; yellowish brown (10YR 5/6) clay loam; dark yellowish brown (10YR 4/4) coating on peds; moderate medium subangular blocky structure; firm; thin discontinuous clay films; few fine dark accumulations of manganese and iron oxides; medium acid; gradual smooth boundary.

C—50 to 60 inches; yellowish brown (10YR 5/6) loam; few medium faint strong brown (7.5YR 5/8) mottles; massive; friable; few fine dark accumulations of manganese and iron oxides; slightly acid.

The solum ranges from 30 to about 50 inches in thickness. The A1 horizon has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. The A2 horizon has hue of 10YR, value of 4 or 5, and chroma of 2 through 4. Typically, the A horizon is loam, but in some pedons it is silt loam or light clay loam. The B2 horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of dominantly 4 through 6.

Liscomb series

The Liscomb series consists of well drained or moderately well drained soils on convex side slopes on uplands. Permeability is moderate. These soils formed in loamy glacial till or loamy surficial sediment overlying glacial till. Native vegetation was prairie grasses. Slope ranges from 5 to 18 percent.

Liscomb soils are similar to Shelby soils and are commonly adjacent to Colo, Dinsdale, and Tama soils. Shelby soils have an argillic horizon and do not have sandy clay loam in the substratum. Colo soils formed in silty sediment on bottom lands and have a thicker mollic epipedon. Dinsdale soils formed in loess overlying glacial till. They are upslope from Liscomb soils. Tama soils formed in loess, have argillic horizons, and are upslope from Liscomb soils.

Typical pedon of Liscomb loam, 9 to 14 percent slopes, 920 feet west and 840 feet north of the southeast corner of sec. 1, T. 85 N., R. 19 W.

A1—0 to 5 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak very fine subangular blocky structure parting to weak very fine granular; friable; few fibrous roots; few worm channels; neutral; gradual smooth boundary.

A3—5 to 12 inches; very dark grayish brown (10YR 3/2) heavy loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure parting to weak very fine granular; friable; few fibrous roots; few worm channels; neutral; clear smooth boundary.

B21—12 to 16 inches; dark brown (10YR 3/3) heavy loam, very dark grayish brown (10YR 3/2) coatings on peds; weak very fine and fine subangular blocky structure; friable; few fibrous roots; few worm channels; medium acid; clear smooth boundary.

B22—16 to 29 inches; dark yellowish brown (10YR 4/4) heavy loam, brown (10YR 4/3) coatings on peds; weak very fine and fine subangular blocky structure; friable; few fibrous roots; few worm channels; slightly acid; gradual smooth boundary.

B23—29 to 35 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) loam; common medium faint yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few fibrous roots; few pebbles; slightly acid; clear smooth boundary.

B3—35 to 42 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) heavy loam; common fine faint grayish brown (2.5Y 5/2) and few fine faint yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few pebbles; slightly acid; gradual wavy boundary.

C1—42 to 50 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) heavy loam; common fine faint grayish brown (2.5Y 5/2) and few fine faint yellowish brown (10YR 5/6) mottles; massive; some vertical cleavage; firm; few pebbles; few fine calcium carbonate concretions; neutral; diffuse boundary.

C2—50 to 60 inches; mottled dark yellowish brown (10YR 4/4), yellowish brown (10YR 5/6), and grayish brown (2.5Y 5/2) heavy loam; massive; firm; few fine calcium carbonate concretions; mildly alkaline.

The solum ranges from 41 to 58 inches in thickness and is commonly to the same depth as carbonates.

The A horizon is neutral to medium acid. The A1 or Ap horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). The A1 and A3 horizons are typically loam that is 20 to 35 percent sand.

The B horizons are medium acid to neutral. The B horizon is loam or sandy clay loam and may have thin subhorizons of sandy loam or loamy sand. The B21 horizon ranges from very dark grayish brown (10YR 3/2) to brown (10YR 4/3) light clay loam, sandy clay loam, or loam. The lower part of the B horizon has hue of 10YR, value of 4 or 5, and chroma of 3 through 6.

The C horizon has hue of 10YR, 2.5Y, or 5Y; value of 4 through 6; and chroma of 1 through 8. The C horizon is loam or sandy clay loam and is slightly acid to mildly alkaline.

Muscatine series

The Muscatine series consists of somewhat poorly drained soils on loess-covered divides. Permeability is moderate. These soils formed in loess. Native vegetation was prairie grasses. Slope ranges from 1 to 3 percent.

Muscatine soils are similar to Nevin soils and are commonly adjacent to Garwin and Tama soils. Nevin soils have thicker A horizons and are on lower stream benches than Muscatine soils. Garwin soils are on lower lying areas. They are poorly drained and have a grayer subsoil than Muscatine soils. Tama soils have brown B horizons and are well drained. They are on higher lying convex slopes.

Typical pedon of Muscatine silty clay loam, 1 to 3 percent slopes, 700 feet east and 1,670 feet south of the northwest corner of sec. 8, T. 85 N., R. 17 W.

Ap—0 to 9 inches; black (10YR 2/1) light silty clay loam, dark gray (10YR 4/1) dry; weak very fine granular structure; friable; slightly acid; abrupt smooth boundary.

A12—9 to 15 inches; black (10YR 2/1) light silty clay loam, dark gray (10YR 4/1) dry; weak very fine granular structure; friable; slightly acid; gradual smooth boundary.

A13—15 to 19 inches; very dark brown (10YR 2/2) light silty clay loam, black (10YR 2/1) coatings on peds, dark grayish brown (10YR 4/2) dry; moderate fine and medium granular structure; friable; slightly acid; gradual smooth boundary.

B1—19 to 23 inches; very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) light silty clay loam; moderate fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

B21t—23 to 27 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine faint yellowish brown (10YR 5/4) mottles; moderate fine subangular blocky structure; friable; thin discontinuous clay films; slightly acid; gradual smooth boundary.

B22t—27 to 32 inches; dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) silty clay loam; few fine faint yellowish brown (10YR 5/4) mottles; moderate fine subangular blocky structure; friable; thin discontinuous clay films; very dark gray (10YR 3/1) worm casts; neutral; gradual smooth boundary.

B31t—32 to 39 inches; grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4) silty clay loam; common fine faint yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; thin discontinuous clay films; few fine dark accumulations of manganese and iron oxides; neutral; gradual smooth boundary.

B32—39 to 46 inches; grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4) light silty clay loam; common fine faint yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; few fine dark accumulations of manganese and iron oxides; neutral; diffuse boundary.

C—46 to 60 inches; grayish brown (2.5Y 5/2) light silty clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; common fine dark accumulations of manganese and iron oxides; neutral.

The solum ranges from 40 to 60 inches in thickness. The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) and typically ranges from 14 to 20 inches in thickness. The B horizon ranges from very dark grayish brown (10YR 3/2) and dark grayish brown (10YR or 2.5Y 4/2) in the upper part to value of 5 or 6 and chroma of 2

or 4 in the lower part. The B2t horizon ranges from 27 to 35 percent clay. The lower part of the B3 horizon and the C horizon typically have hue of 10YR to 2.5Y, value of 5 or 6, and chroma of 2.

Nevin series

The Nevin series consists of somewhat poorly drained soils on low stream benches or second bottoms. Permeability is moderate. These soils formed in silty alluvium. Native vegetation was prairie grasses. Slope ranges from 1 to 3 percent.

Nevin soils are similar to Ely, Koszta, and Muscatine soils and are commonly adjacent to Bremer and Wiota soils. Ely soils do not have an argillic horizon. Koszta soils do not have a mollic epipedon. They have an A2 horizon, have more contrast in the amount of clay between the A and B horizons, and are more acid than Nevin soils. Muscatine soils have thinner A horizons and formed entirely in loess. Bremer soils are poorly drained and have B horizons that are higher in clay content. They are on the lower and more nearly level parts of the low stream benches or high second bottoms. Wiota soils have browner B horizons and are well drained. Wiota soils are on slightly convex rises or short slopes or stream benches.

Typical pedon of Nevin silty clay loam, 1 to 3 percent slopes, 1,230 feet south and 1,150 feet west of the northeast corner of sec. 31, T. 84 N., R. 17 W.

Ap—0 to 6 inches; black (10YR 2/1) light silty clay loam, very dark gray (10YR 3/1) dry; weak very fine granular structure; friable; few fibrous roots; few worm channels; medium acid; abrupt smooth boundary.

A12—6 to 13 inches; black (10YR 2/1) light silty clay loam, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure parting to weak very fine granular; friable; few fibrous roots; few worm channels; medium acid; gradual smooth boundary.

A13—13 to 19 inches; very dark gray (10YR 3/1) silty clay loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure parting to weak very fine granular; friable; few fibrous roots; few worm channels; medium acid; clear smooth boundary.

A3—19 to 24 inches; very dark grayish brown (10YR 3/2) silty clay loam, very dark gray (10YR 3/1) coatings on peds, dark grayish brown (10YR 4/2) dry; few fine faint dark grayish brown (10YR 4/2) mottles; weak very fine subangular blocky structure; friable; few fibrous roots; few worm channels; slightly acid; clear smooth boundary.

B21t—24 to 29 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) coatings on peds; few fine faint brown (10YR 4/3) mottles; weak medium prismatic structure parting to weak fine and very fine subangular blocky; friable; few fibrous roots; thin discontinuous clay films; few worm channels; slightly acid; clear smooth boundary.

B22t—29 to 35 inches; grayish brown (2.5Y 5/2) silty clay loam, dark gray (10YR 4/1) coatings on peds, dark grayish brown (10YR 4/2) kneaded; few fine faint brown (10YR 5/3) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few fibrous roots; thin discontinuous clay films; few worm channels; neutral; gradual smooth boundary.

B3—35 to 47 inches; grayish brown (2.5Y 5/2) light silty clay loam, grayish brown (10YR 5/2) coatings on peds; few fine faint brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak coarse subangular blocky; friable; few fibrous roots; few worm channels; few fine dark accumulations of manganese and iron oxides; neutral; gradual smooth boundary.

C—47 to 60 inches; grayish brown (2.5Y 5/2) light silty clay loam; few medium faint yellowish brown (10YR 5/6) mottles; massive; friable; few fibrous roots; few worm channels; few fine dark accumulations of manganese and iron oxides; neutral.

The solum ranges from 36 to 60 inches in thickness. The A horizon ranges from 18 to 30 inches in thickness. It ranges in clay content from 24 to 32 percent. Some pedons have a B1 horizon. The B horizon has chroma of 2 or 3 and mottles of higher chroma. The B horizon ranges from 32 to 36 percent clay. The C horizon is silt loam or silty clay loam and is stratified in some pedons.

Nicollet series

The Nicollet series consists of somewhat poorly drained soils on plane or slightly convex ground moraines, toe slopes, and at the heads of drainageways. Permeability is moderate. These soils formed in friable, calcareous loam or clay loam till of Late Wisconsin age. Native vegetation was prairie grasses. Slope ranges from 1 to 3 percent.

Nicollet soils are similar to Webster soils and are commonly adjacent to Canisteo, Clarion, and Webster soils. Webster soils are on broad, nearly level areas. They have grayer B horizons than Nicollet soils and are poorly drained. Canisteo soils are calcareous, poorly drained, and are in lower lying areas. Clarion soils are on convex slopes that have gradients of more than 3 percent. They are well drained.

Typical pedon of Nicollet loam, 1 to 3 percent slopes, 1,740 feet north and 96 feet west of the southeast corner of sec. 5, T. 84 N., R. 20 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular structure parting to weak fine granular; friable; common fibrous roots; slightly acid; abrupt smooth boundary.

A12—8 to 14 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak and moderate fine subangular blocky structure; friable; common fibrous roots; slightly acid; gradual smooth boundary.

A3—14 to 20 inches; very dark gray (10YR 3/1) loam, very dark grayish brown (10YR 4/2) dry; weak and moderate fine subangular blocky structure; friable; common fibrous roots; slightly acid; gradual smooth boundary.

B1—20 to 24 inches; dark grayish brown (10YR 4/2) light clay loam, very dark grayish brown (10YR 3/2) coatings on some peds; weak medium prismatic structure parting to moderate fine and medium subangular blocky; friable; few fibrous roots; few pebbles; slightly acid; gradual smooth boundary.

B21—24 to 29 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium prismatic structure parting to moderate fine and medium subangular blocky; friable; few fibrous roots; few very dark grayish brown (10YR 3/2) root channels; slightly acid; gradual smooth boundary.

B22—29 to 33 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine prominent strong brown (7.5YR 5/8) mottles, few fine distinct yellowish brown (10YR 5/6) mottles, and few fine faint grayish brown (2.5Y 5/2) mottles; weak moderate prismatic structure parting to moderate fine and medium subangular blocky; friable; few fibrous roots; few pebbles; common fine dark accumulations of manganese and iron oxides; slightly acid; clear wavy boundary.

C1—33 to 44 inches; grayish brown (2.5Y 5/2) loam; few fine faint light brownish gray (2.5Y 6/2) mottles and common fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; few fibrous roots; few pebbles; common fine dark accumulations of manganese and iron oxides; few soft carbonate accumulations; mildly alkaline; gradual wavy boundary.

C2—44 to 60 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6, 5/8) loam; massive; friable; few pebbles; common fine dark accumulations of manganese and iron oxides; few soft carbonate accumulations; slight effervescence; mildly alkaline.

Solum is typically 30 to 42 inches in thickness. The depth to carbonates is commonly the same as the solum thickness. The 10- to 40-inch control section typically averages 26 to 33 percent clay.

Typically, the A horizon is loam but ranges to clay loam. It is black (10YR 2/1) or very dark gray (10YR 3/1). The upper part of the B horizon ranges from very dark grayish brown (10YR 3/2) to dark grayish brown (10YR or 2.5Y 4/2). The lower part has hue of 2.5Y, value of 4 or 5, and chroma of 2 to 4. Reaction is slightly acid to mildly alkaline. The C horizon has hue of 2.5Y or 10YR, value of 5, and chroma of 2 to 8.

Nodaway series

The Nodaway series consists of moderately well drained soils on alluvial fans and flood plains. Permeability is moderate. Nodaway soils formed in silty alluvium. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Nodaway soils are similar to Ackmore and Lawson soils and are commonly adjacent to Ackmore, Colo, and Zook soils. Ackmore soils have dark buried soils at a depth of 20 to 36 inches. Lawson soils are somewhat poorly drained and have a mollic epipedon that is 24 to 36 inches thick. Colo soils are on wide bottom lands and in upland drainageways. They are poorly drained and have a mollic epipedon that is more than 36 inches thick. Zook soils commonly are at some distance from the main stream channel and on the low parts of first bottoms. They are poorly drained, have a higher clay content than Nodaway soils, and have a mollic epipedon more than 36 inches thick.

Typical pedon of Nodaway silt loam, 0 to 2 percent slopes, 230 feet north and 1,450 feet west of the southeast corner of sec. 5, T. 82 N., R. 17 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, gray (10YR 5/1) and grayish brown (10YR 5/2) dry; weak very fine subangular blocky structure; friable; common fibrous roots; few worm channels; neutral; abrupt smooth boundary.

C—7 to 57 inches; stratified, very dark gray (10YR 3/1), very dark grayish brown (10YR 3/2), dark grayish brown (10YR 4/2), and grayish brown (10YR 5/2) silt loam; few fine faint yellowish brown (10YR 5/6) mottles; finely stratified breaking to thin platy fragments; friable; few fibrous roots; few worm channels; neutral; abrupt smooth boundary.

Ab—57 to 60 inches; black (10YR 2/1) light silty clay loam; weak fine subangular blocky structure parting to weak fine granular; friable; neutral.

The A and C horizons are silt loam, or in some places, light silty clay loam that has a few very thin lenses of fine sand or coarser material at a depth of less than 40 inches. The Ap horizon is dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The control section is neutral or slightly acid.

Okoboji series

The Okoboji series consists of very poorly drained soils on till plains in depressional areas that were formerly lakes or ponds. Permeability is moderately slow. These soils formed in 4 to 12 feet of silty alluvium washed from till on the surrounding slopes. Native vegetation was prairie grasses. Slope is less than 1 percent.

Okoboji soils are similar to Zook soils and commonly adjacent to Canisteo, Harps, and Webster soils. Zook

soils are poorly drained and are on flood plains. Canisteo, Harps, and Webster soils are higher in sand content and have a thinner, dark surface layer. Canisteo and Webster soils are on nearly level areas near the depressions. Harps soils form a convex shoreline rim around Okoboji soils.

Typical pedon of Okoboji silty clay loam, 0 to 1 percent slopes, 740 feet north and 1,000 feet east of the southwest corner of sec. 17, T. 85 N., R. 20 W.

Ap—0 to 8 inches; black (N 2/0) light silty clay loam, very dark gray (10YR 3/1) dry; weak medium granular structure; friable; common roots; neutral; gradual smooth boundary.

A12—8 to 17 inches; black (N 2/0) light silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; few root channels; neutral; gradual smooth boundary.

A13—17 to 23 inches; very dark gray (N 3/0) silty clay loam, black (N 2/0) coatings on peds, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; few root channels; neutral; gradual smooth boundary.

A3—23 to 28 inches; very dark gray (N 3/0) silty clay loam, dark gray (10YR 4/1) dry; few fine faint dark olive gray (5Y 3/2) mottles; weak medium subangular blocky structure; friable; few root pores; neutral; gradual smooth boundary.

B21g—28 to 33 inches; very dark gray (N 3/0) silty clay loam; few fine distinct dark gray (5Y 4/1) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few root pores; neutral; gradual smooth boundary.

B22g—33 to 39 inches; very dark gray (10YR 3/1) silty clay loam; common medium distinct dark gray (5Y 4/1) mottles; weak medium subangular blocky structure; few root pores; neutral; clear smooth boundary.

B3g—39 to 44 inches; olive (5Y 5/3) and gray (5Y 5/1) light silty clay loam, dark olive gray (5Y 5/2) coatings on peds; few fine distinct light olive brown (2.5Y 5/6) mottles; weak coarse subangular blocky structure; friable; few root pores; neutral; gradual smooth boundary.

Clg—44 to 53 inches; gray (5Y 5/1) light silty clay loam, very dark gray (5Y 3/1) coatings on peds; common medium distinct olive (5Y 5/4) mottles; massive; friable; few root pores; slight effervescence; mildly alkaline; diffuse wavy boundary.

C2g—53 to 60 inches; gray (5Y 5/1) light silty clay loam, very dark gray (5Y 3/1) coatings on peds; common medium distinct olive (5Y 5/4) mottles; massive; friable; few root pores; slight effervescence; moderately alkaline.

The solum is typically 40 to 60 inches thick. The depth to carbonates is commonly the same as the solum thickness.

The A horizon is black (N 2/0 or 10YR 2/1) or very dark gray (N 3/0) silty clay loam or silt loam. It has value of 3 or less extending to a depth of 24 to 48 inches. The lower part of the Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1, 2, or 3. The C horizon is typically silty clay loam that has thin strata of silt loam.

Saude series

The Saude series consists of well drained soils on benches along streams and on outwash areas. Permeability is moderate in the upper part and very rapid in the lower part. These soils formed in stratified loamy alluvium over loamy sand and gravelly sand. Native vegetation was prairie grasses. Slope ranges from 1 to 9 percent.

Saude soils are similar to Dickinson and Waukee soils and are commonly adjacent to Lawler, Hanska, and Waukee soils. Dickinson soils do not have coarse sand and gravel in the lower part of the solum and C horizon and are coarser textured in the upper part of the solum. Waukee soils have more clay in the upper part of the B horizon and are deeper to contrasting textures. They are in positions similar to Saude soils. Lawler and Hanska soils are more nearly level, are more poorly drained, and are deeper to contrasting layers.

Typical pedon of Saude loam, 1 to 3 percent slopes, 1,960 feet east and 95 feet south of the center of sec. 15, T. 85 N., R. 19 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; friable; few fibrous roots; few worm channels; slightly acid; clear smooth boundary.

A12—6 to 14 inches; black (10YR 2/1) and very dark brown (10YR 2/2) loam, very dark brown (10YR 2/2) kneaded, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few fibrous roots; few worm channels; slightly acid; gradual smooth boundary.

B1—14 to 22 inches; dark brown (10YR 3/3) light loam; weak fine subangular blocky structure; friable; few fibrous roots; few worm channels; slightly acid; gradual smooth boundary.

B2—22 to 27 inches; dark brown (10YR 3/3) sandy loam; weak fine subangular blocky structure; very friable; few fibrous roots; medium acid; gradual smooth boundary.

IIB3—27 to 35 inches; dark yellowish brown (10YR 4/4) loamy sand; single grain; loose; many pebbles, band of pebbles at 29 inches; medium acid; abrupt smooth boundary.

IIC1—35 to 48 inches; yellowish brown (10YR 5/4) and dark yellowish brown (10YR 4/4) gravelly loamy sand; single grain; loose; medium acid; clear smooth boundary.

IIC2—48 to 55 inches; yellowish brown (10YR 5/4) gravelly sandy loam; weak fine subangular blocky

structure; loose; medium acid; gradual smooth boundary.

IIC3—55 to 60 inches; dark yellowish brown (10YR 4/4) gravelly loamy sand; single grain; loose; medium acid.

The solum ranges from 24 to 44 inches in thickness. Depth to loamy sand, gravelly loamy sand, or sand ranges from 20 to 32 inches.

The A horizon ranges from 11 to 16 inches in thickness. Reaction is neutral to medium acid. The B2 horizon has hue of 10YR or 7.5YR and chroma of 3 to 6. It is slightly acid to strongly acid. Sand is dominantly medium to coarse. Some strata in the IIC horizon are as much as 50 percent gravel, by volume. The upper part of the IIC horizon is medium acid to strongly acid.

Shelby series

The Shelby series consists of well drained and moderately well drained soils on convex side slopes and nose slopes on uplands. Permeability is moderately slow. These soils formed in clay loam glacial till of Kansan or Nebraskan age. Native vegetation was prairie grasses. Slope ranges from 9 to 25 percent.

Shelby soils are similar to Liscomb and Gara soils and are commonly adjacent to Adair, Killduff, Clarinda, and Tama soils. Liscomb soils have B2 horizons that are heavy loam or sandy clay loam and are more friable than Shelby soils. Gara soils have an A2 horizon. Adair soils are of redder hue, have more clay in the B2t horizons, and are at a higher elevation. Killduff soils formed in loess and are upslope at the heads of drainageways. Clarinda soils have gray Bt horizons that contain more clay and are at a higher elevation than Shelby soils. Tama soils formed in loess and are upslope.

Typical pedon of Shelby loam, 14 to 18 percent slopes, moderately eroded, 2,140 feet north and 54 feet east of the southwest corner of sec. 27, T. 82 N., R. 19 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) loam with some mixing of dark brown (10YR 3/3) and brown (10YR 4/3), dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few fibrous roots; few small pebbles; slightly acid; abrupt smooth boundary.

B1t—7 to 12 inches; dark yellowish brown (10YR 4/4) clay loam, some very dark grayish brown (10YR 3/2) coatings on peds; moderate fine subangular blocky structure; firm; few fibrous roots; thin discontinuous clay films; medium acid; gradual smooth boundary.

B21t—12 to 20 inches; yellowish brown (10YR 5/4) clay loam; few fine faint strong brown (7.5YR 4/6) mottles; moderate very fine and fine subangular blocky structure; firm; few fibrous roots; thin discontinuous clay films; medium acid; gradual smooth boundary.

B22t—20 to 27 inches; yellowish brown (10YR 5/4) clay loam; few fine faint strong brown (7.5YR 4/6) and few medium faint grayish brown (2.5Y 5/2) mottles; moderate fine and medium subangular blocky structure; firm; few fibrous roots; thin discontinuous clay films; medium acid; gradual smooth boundary.

B23t—27 to 38 inches; mottled yellowish brown (10YR 5/6), grayish brown (2.5Y 5/2), and strong brown (7.5YR 4/6) clay loam; weak medium prismatic structure parting to weak medium subangular blocky; firm; thin discontinuous clay films; few fine soft dark accumulations of manganese and iron oxides; medium acid; gradual smooth boundary.

B3t—38 to 45 inches; mottled yellowish brown (10YR 5/6) and grayish brown (2.5Y 5/2) clay loam; weak medium prismatic structure parting to weak medium subangular blocky; firm; few fine dark accumulations of manganese and iron oxides; medium acid; gradual smooth boundary.

C1—45 to 55 inches; mottled yellowish brown, brown (10YR 5/4, 5/6), and grayish brown (2.5Y 5/2) clay loam; massive; firm; few fine dark accumulations of manganese and iron oxides; slightly acid; gradual smooth boundary.

C2—55 to 60 inches; mottled yellowish brown (10YR 5/6) and light brownish gray (2.5Y 6/2) clay loam; massive; firm; mildly alkaline.

The solum ranges from 30 to 50 inches in thickness. The Ap horizon ranges from very dark grayish brown (10YR 3/2) to brown (10YR 4/3) loam or light clay loam. It is 4 to 9 inches thick. The B2t horizon typically averages 32 to 35 percent clay, but some parts range up to 38 percent clay. It is brown (10YR 4/3), dark yellowish brown (10YR 4/4), or yellowish brown (10YR 5/4, 5/6). Reaction is slightly acid to strongly acid. The C horizon is heavy loam to clay loam and is mildly alkaline or moderately alkaline.

Sparta series

The Sparta series consists of excessively drained soils on convex ridgetops, side slopes and crests of escarpments, and convex dunes along stream benches. Permeability is rapid. These soils formed in eolian sand or in sandy alluvium reworked by wind. Native vegetation was mixed deciduous trees and prairie grasses. Slope ranges from 2 to 14 percent.

Sparta soils are similar to Dickinson soils and are commonly adjacent to Chelsea, Dickinson, and Tama soils. All of these soils are in similar positions. Dickinson soils have less sand in the control section and are higher in organic matter content than Sparta soils. Chelsea soils do not have a mollic epipedon. Tama soils formed in the loess and are silty throughout the solum.

Typical pedon of Sparta loamy fine sand, 5 to 9 percent slopes, 335 feet south and 1,190 feet east of the center of sec 4, T. 84 N., R. 19 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) loamy fine sand, brown (10YR 4/3) dry; weak medium subangular blocky structure; very friable; few fibrous roots; neutral; abrupt smooth boundary.
A3—7 to 19 inches; very dark grayish brown (10YR 3/2) loamy fine sand, brown (10YR 4/3) dry; weak coarse subangular blocky structure; very friable; few fibrous roots; medium acid; clear smooth boundary.
B2—19 to 33 inches; dark yellowish brown (10YR 4/4) loamy fine sand; very friable; medium acid; gradual smooth boundary.
C—33 to 60 inches; yellowish brown (10YR 5/4) sand; single grain; loose; medium acid.

The solum ranges from 24 to 40 inches in thickness. The mollic epipedon ranges from 10 to 24 inches in thickness.

The A1 horizon has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. It is loamy sand or loamy fine sand. The B2 horizon has hue of 10YR or 7.5YR and value and chroma of 3 through 6. It is sand, fine sand, loamy sand, or loamy fine sand. Reaction is medium acid or strongly acid.

Sperry series

Sperry series consists of very poorly drained soils in slight depressions on upland divides and stream benches. Permeability is slow. These soils formed predominantly in loess. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Sperry soils are similar to Vesser soils and are commonly adjacent to Garwin and Muscatine soils. Vesser soils are better drained and are not in depressional areas. Garwin soils do not have an A2 horizon, have lower clay content in the solum, and are poorly drained. Muscatine soils are somewhat poorly drained, have a browner B horizon than Sperry soils, and do not have an A2 horizon. Garwin and Muscatine soils are on higher lying areas.

Typical pedon of Sperry silt loam, 0 to 2 percent slopes, 520 feet north and 1,200 feet west of the center of sec. 13, T. 85 N., R. 19 W.

A1—0 to 10 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; common fibrous roots; slightly acid; abrupt smooth boundary.
A21—10 to 14 inches; mixed very dark gray (10YR 3/1) and dark gray (5Y 4/1) light silt loam, gray (10YR 6/1) dry; moderate thick platy structure; friable; common fibrous roots; few worm channels; slightly acid; abrupt smooth boundary.
A22—14 to 22 inches; gray (5Y 5/1) light silt loam, light gray (10YR 7/1) dry; common medium prominent strong brown (7.5YR 5/8) mottles; moderate thick platy structure; friable; few fibrous roots; few worm channels; slightly acid; abrupt smooth boundary.
B21tg—22 to 30 inches; gray (5Y 5/1) light silty clay, dark gray (5Y 4/1) and very dark gray (5Y 3/1) coatings on peds; common fine prominent yellowish red (5YR 5/6) mottles; weak medium prismatic structure parting to strong fine subangular blocky; very firm; thin discontinuous clay films; few fibrous roots; medium acid; gradual smooth boundary.
B22tg—30 to 37 inches; gray (5Y 5/1) heavy silty clay loam; common prominent yellowish red (5YR 5/8) mottles; weak medium prismatic structure parting to moderate medium blocky; firm; thin discontinuous clay films; few fibrous roots; medium acid; gradual smooth boundary.
B23tg—37 to 45 inches; light olive gray (5Y 6/2) silty clay loam; common medium prominent yellowish red (5YR 5/8) mottles; moderate medium blocky structure; firm; thin discontinuous clay films; slightly acid; diffuse boundary.
B3g—45 to 57 inches; light gray (5Y 6/1) light silty clay loam; common medium prominent strong brown (7.5YR 5/8) mottles; weak coarse subangular blocky structure; friable; slightly acid; diffuse wavy boundary.
C—57 to 60 inches; light gray (5Y 6/1) light silty clay loam; common medium prominent strong brown (7.5YR 5/8) mottles; massive; friable; slightly acid.

The solum ranges from 40 to 68 inches in thickness. The A1 or Ap horizon is very dark gray (10YR 3/1) or black (10YR 2/1). The A horizon ranges from 16 to 24 inches in thickness. The B2tg horizon ranges from light silty clay loam to silty clay. Maximum clay content is 48 percent. Reaction in the solum ranges from slightly acid to strongly acid.

Spillville series

The Spillville series consists of moderately well drained and somewhat poorly drained soils on nearly level bottom lands. Permeability is moderate. Spillville soils formed in loamy alluvium. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Spillville soils are similar to Terril soils and are commonly adjacent to Colo, Lawson, and Terril soils. Terril soils have thinner A horizons, browner B horizons, and are well drained. They are on foot slopes above Spillville soils. Colo soils are poorly drained. Colo and Lawson soils are silty and are closer to the stream channel than Spillville soils.

Typical pedon of Spillville loam, 0 to 2 percent slopes, 600 feet west and 700 feet south of the northeast corner of sec. 10, T. 84 N., R. 20 W.

A11—0 to 14 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky

structure parting to weak fine granular; friable; few fibrous roots; neutral; gradual smooth boundary.

A12—14 to 29 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure parting to weak fine granular; friable; few fibrous roots; neutral; gradual smooth boundary.

A13—29 to 40 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to weak fine and medium subangular blocky; friable; few fibrous roots; neutral; gradual smooth boundary.

C—40 to 60 inches; very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) heavy loam; massive; firm; few pebbles; neutral.

The solum is typically about 40 inches thick but ranges from 30 to 56 inches. It is commonly neutral or slightly acid throughout. Weighted average clay content of the 10- to 40-inch control section is 18 to 25 percent. Below a depth of 36 inches the texture is commonly loam but ranges from clay loam to sandy loam.

Storden series

The Storden series consists of well drained soils on convex side slopes on till plains of Late Wisconsin age. Permeability is moderate. These soils formed in calcareous loam glacial till. Native vegetation was mixed deciduous trees and prairie grasses. Slope ranges from 9 to 14 percent.

Storden soils are commonly adjacent to Clarion soils. The well drained Clarion soils are leached of carbonates to a greater depth than Storden soils, and they have a B horizon. The Clarion soils are in similar positions.

Typical pedon of Storden loam, 9 to 14 percent slopes, moderately eroded, 460 feet east and 141 feet north of the southwest corner of sec. 17, T. 84 N., R. 20 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) loam mixed with some light yellowish brown (10YR 6/4), very dark grayish brown (10YR 3/2) coatings on peds, brown (10YR 5/3) dry; weak medium granular structure; friable; common fibrous roots; common small pebbles; common calcium carbonate accumulations; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1—8 to 26 inches; light yellowish brown (10YR 6/4) loam; massive; friable; few fibrous roots; few small pebbles; common calcium carbonate accumulations; violent effervescence; moderately alkaline; clear wavy boundary.

C2—26 to 47 inches; pale brown (10YR 6/3) loam; common medium distinct strong brown (7.5YR 5/8) mottles; massive; friable; few small pebbles; common calcium carbonate accumulations; violent effervescence; moderately alkaline; clear wavy boundary.

C3—47 to 60 inches; light brownish gray (2.5Y 6/2) loam; common medium distinct strong brown (7.5YR 5/6) mottles; massive; friable; few small pebbles; common calcium carbonate accumulations; violent effervescence; moderately alkaline.

The thickness of solum commonly is the same as the thickness of the A horizon. The control section averages 18 to 27 percent clay and 20 to 40 percent fine sand and coarser.

The Ap horizon has hue of 10YR, value of 4 or 5, (3 in a few masses) and chroma of 2 or 3. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 through 6. Hue of 2.5Y commonly is below a depth of about 30 inches.

Tama series

The Tama series consists of well drained soils on loess-covered uplands. Permeability is moderate. These soils formed in loess. Native vegetation was prairie grasses. Slope ranges from 0 to 18 percent.

Tama soils are similar to Dinsdale, Downs, and Killduff soils and are adjacent to Liscomb, Muscatine, and Shelby soils. Dinsdale soils have B horizons that formed in silty and loamy material. Downs soils have lighter colored A horizons than Tama soils. Killduff soils do not have a mollic epipedon. Liscomb and Shelby soils are downslope and formed in loamy glacial till. Muscatine soils are on less sloping areas, have a thicker mollic epipedon, and are somewhat poorly drained.

Typical pedon of Tama silty clay loam, 2 to 5 percent slopes, 831 feet south and 540 feet west of the northeast corner of sec. 14, T. 85 N., R. 17 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) light silty clay loam, black (10YR 2/1) coatings on peds, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; friable; common fibrous roots; slightly acid; clear smooth boundary.

A12—7 to 12 inches; very dark brown (10YR 2/2) silty clay loam; black (10YR 2/1) coatings on peds, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; common fibrous roots; slightly acid; gradual smooth boundary.

A3—12 to 16 inches; very dark grayish brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) coatings on peds, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; common fibrous roots; medium acid; gradual smooth boundary.

B1—16 to 22 inches; brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) coatings on peds; weak medium prismatic structure parting to moderate fine subangular blocky; friable; few fibrous roots; medium acid; gradual smooth boundary.

B21t—22 to 32 inches; brown (10YR 4/3) silty clay loam; weak medium prismatic structure parting to

moderate fine subangular blocky; friable; few fibrous roots; thin discontinuous dark brown (10YR 3/3) clay films; medium acid; gradual smooth boundary.

B22t—32 to 38 inches; yellowish brown (10YR 5/4) light silty clay loam; few fine faint grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; friable; few fibrous roots; thin discontinuous brown (10YR 4/3) clay films; few fine dark accumulations of manganese and iron oxides; medium acid; gradual smooth boundary.

B3—38 to 47 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) light silty clay loam; few fine faint yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; friable; few fibrous roots; few fine dark accumulations of manganese and iron oxides; medium acid; gradual smooth boundary.

C—47 to 60 inches; brown (10YR 5/3) light silty clay loam; few fine faint yellowish brown (10YR 5/6) and light brownish gray (10YR 6/2) mottles; massive; friable; few fibrous roots; slightly acid.

The solum ranges from 36 to 60 inches in thickness.

The A1 horizon is black (10YR 2/1) or very dark brown (10YR 2/2). It is light silty clay loam or silt loam. The A1 horizon is 10 to 20 inches thick and ranges from slightly acid to strongly acid. The B2t horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/4, 5/6). It is 8 to 20 inches thick and is medium acid or strongly acid. The C horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/6). It is light silty clay loam or heavy silt loam.

The Tama soils in map units 120C2, 120D2, and 120E2 are taxadjuncts to the Tama series because they do not have a mollic epipedon that is definitive for the Tama series. These soils have an A horizon that is 3 to 9 inches thick.

Terril series

The Terril series consists of moderately well drained soils on plane surfaces to slightly concave foot slopes. Permeability is moderate. These soils formed in loamy local alluvium derived from glacial till of mixed mineralogy. Native vegetation was prairie grasses. Slope ranges from 5 to 9 percent.

Terril soils are similar to Spillville soils and are commonly adjacent to Clarion, Colo, and Storden soils. Spillville soils have lower chroma in the lower part of the control section and are moderately well drained and somewhat poorly drained. Clarion and Storden soils have thinner mollic epipedons and are less deep to carbonates than Terril soils. They are on convex slopes on uplands. Colo soils are silty and poorly drained. They are on bottom lands.

Typical pedon of Terril loam, sandy substratum, 5 to 9 percent slopes, 440 feet south and 165 feet east of the northwest corner of sec. 18, T. 84 N., R. 20 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; common fibrous roots; slightly acid; clear smooth boundary.

A12—9 to 18 inches; black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; common fibrous roots; slightly acid; gradual smooth boundary.

A13—18 to 26 inches; black (10YR 2/1) loam, very dark brown (10YR 2/2) kneaded, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; few fibrous roots; slightly acid; gradual smooth boundary.

A3—26 to 32 inches; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) coatings on peds, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; few fibrous roots; slightly acid; gradual smooth boundary.

B1—32 to 37 inches; dark brown (10YR 3/3) loam, very dark gray (10YR 3/1) coatings on peds; weak fine subangular blocky structure; friable; few fibrous roots; slightly acid; gradual smooth boundary.

B2—37 to 49 inches; brown (10YR 4/3) loam; weak medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B3—49 to 60 inches; brown (10YR 4/3) sandy loam; very weak medium subangular blocky structure; very friable; few small pebbles; neutral.

The solum ranges from 3 to 6 feet in thickness. The soil is commonly free of carbonates to a depth of 50 inches or more.

The A horizon ranges from 24 to 36 inches in thickness. It is generally loam, but some A horizons are silt loam high in sand content. The lower part of the B horizon and the C horizon range from sandy loam to stratified sand.

Vesser series

The Vesser series consists of somewhat poorly drained or poorly drained soils on high bottoms, foot slopes, and fans. Permeability is moderate. These soils formed in silty alluvium. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Vesser soils are similar to Sperry soils and are commonly adjacent to Colo and Judson soils. Sperry soils are in depressional areas and are very poorly drained. Colo and Judson soils do not have A2 horizons. Colo soils are on bottom lands and are poorly drained. Judson soils are on foot slopes and are well drained or moderately well drained.

Typical pedon of Vesser silt loam, 0 to 2 percent slopes, 860 feet north and 780 feet east of the southwest corner of sec. 20, T. 82 N., R. 20 W.

A11—0 to 11 inches; black (10YR 2/1) heavy silt loam, very dark brown (10YR 2/2) kneaded, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure parting to moderate fine granular; friable; few fibrous roots and worm channels; slightly acid; clear smooth boundary.

A12—11 to 17 inches; very dark grayish brown (10YR 3/2) heavy silt loam, black (10YR 2/1) and very dark brown (10YR 2/2) coatings on peds, gray (10YR 5/1) dry; weak very fine subangular blocky structure parting to moderate fine granular; friable; few fibrous roots; few worm channels; medium acid; clear smooth boundary.

A21—17 to 22 inches; dark gray (10YR 4/1) silt loam, very dark grayish brown (10YR 3/2) coatings on peds, gray (10YR 6/1) dry; weak medium platy structure parting to moderate very fine subangular blocky; friable; few fibrous roots; thin discontinuous light gray (10YR 7/1) dry silt coats; few worm channels; medium acid; gradual smooth boundary.

A22—22 to 28 inches; dark grayish brown (10YR 4/2) silt loam, dark gray (10YR 4/1) coatings on peds, gray (10YR 6/1) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; weak medium platy structure parting to moderate medium subangular blocky; friable; few fibrous roots; thin discontinuous light gray (10YR 7/1) dry silt coats; few worm channels; medium acid; clear smooth boundary.

B21tg—28 to 35 inches; very dark gray (10YR 3/1) and dark gray (10YR 4/1) light silty clay loam; common fine distinct yellowish brown (10YR 4/4) and brown (7.5YR 4/4) mottles; weak medium prismatic structure parting to weak fine angular blocky; firm; few fibrous roots; thin discontinuous clay films; thin discontinuous light gray (10YR 7/1) dry silt coats; medium acid; gradual smooth boundary.

B22tg—35 to 41 inches; very dark gray (10YR 3/1) silty clay loam; common coarse distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky structure; firm; few fibrous roots; thin discontinuous clay films; thin discontinuous light gray (10YR 7/1) dry silt coats; medium acid; clear smooth boundary.

B3tg—41 to 55 inches; very dark gray (10YR 3/1) silty clay loam; many coarse distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; weak medium prismatic structure; firm; few fibrous roots; thin discontinuous clay films; medium acid; gradual smooth boundary.

Cg—55 to 60 inches; dark gray (10YR 4/1) heavy silty clay loam; many coarse distinct brown (7.5YR 4/4) and few medium distinct yellowish brown (10YR 5/6) mottles; massive; firm; few fibrous roots; medium acid.

The solum ranges from 50 to more than 60 inches in thickness. The A1 horizon ranges from 12 to 20 inches in thickness. The A2 horizon is dark gray (10YR 4/1) to grayish brown (10YR 5/2). It commonly ranges from 10 to 20 inches in thickness. The B2tg horizon has hue of 10YR or 2.5Y, value of 3 through 5, and chroma of 1 or 2. Clay content of the B horizon ranges from 27 to 35 percent.

Waukee series

The Waukee series consists of well drained soils on benches along streams and outwash areas. Permeability is moderate in the upper part and very rapid in the lower part. These soils formed in stratified loamy alluvium over sand and gravel. Native vegetation was prairie grasses. Slope ranges from 1 to 3 percent.

Waukee soils are similar to Clarion, Lawler, and Saude soils and are commonly adjacent to Lawler, Hanska, and Saude soils. Clarion soils do not have contrasting textures above a depth of 40 inches. Lawler and Hanska soils are less sloping than Waukee soils and are more poorly drained. Saude soils are not as deep to contrasting textures. They are in positions similar to Waukee soils.

Typical pedon of Waukee loam, 1 to 3 percent slopes, 210 feet north and 300 feet east of the southwest corner of sec. 35, T. 85 N., R. 20 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) heavy loam, dark grayish brown (10YR 4/2) dry; weak fine and very fine granular structure; friable; few fibrous roots; neutral; abrupt smooth boundary.

A12—7 to 13 inches; very dark brown (10YR 2/2) heavy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few fibrous roots; slightly acid; gradual smooth boundary.

A13—13 to 17 inches; very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) heavy loam, very dark grayish brown (10YR 3/2) kneaded, brown (10YR 4/3) dry; weak fine subangular blocky structure; friable; few fibrous roots; slightly acid; gradual smooth boundary.

B1—17 to 21 inches; brown (10YR 4/3) and dark brown (10YR 3/3) loam; weak fine subangular blocky structure; friable; few fibrous roots; medium acid; gradual smooth boundary.

B21—21 to 28 inches; dark yellowish brown (10YR 4/4) loam; weak fine subangular blocky structure; friable; few fibrous roots; medium acid; gradual smooth boundary.

B22—28 to 34 inches; dark yellowish brown (10YR 4/4) loam; weak fine subangular blocky structure; friable; few fibrous roots; medium acid; clear smooth boundary.

B3—34 to 40 inches; yellowish brown (10YR 5/4) loam; weak fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

IIC1—40 to 46 inches; yellowish brown (10YR 5/4) gravelly loamy sand; single grain; loose; medium acid; clear smooth boundary.

IIC2—46 to 60 inches; brown (10YR 5/3) gravelly sand; single grain; loose; slightly acid.

The solum ranges from 30 to 48 inches in thickness. Depth to sandy and gravelly material ranges from 32 to 40 inches.

The A horizon ranges from 12 to 18 inches in thickness. The A1 horizon or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2). The B2 horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 through 6. It is loam or sandy clay loam. The B2 horizon ranges from 18 to 27 percent clay. The IIC horizon typically is more than 10 percent gravel.

Webster series

The Webster series consists of poorly drained soils on till plains of Wisconsin age. Permeability is moderate. These soils formed in loamy glacial till and local alluvium from such till. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Webster soils are similar to Canisteo soils and are commonly adjacent to Clarion, Harps, Nicollet, and Okoboji soils. Canisteo soils are calcareous throughout. Harps soils have a calcic horizon and are on the rims of depressional areas. Nicollet soils have browner B horizons and are less poorly drained than Webster soils. Okoboji soils are in depressional areas and have thicker A horizons.

Typical pedon of Webster silty clay loam, 0 to 2 percent slopes, 1,880 feet north and 87 feet east of the southwest corner of sec. 8, T. 84 N., R. 20 W.

Ap—0 to 5 inches; black (N 2/0) silty clay loam, black (N 2/0) dry; weak very fine subangular blocky structure; friable; few fibrous roots; few worm channels; neutral; abrupt smooth boundary.

A12—5 to 14 inches; black (N 2/0) silty clay loam, black (N 2/0) dry; weak fine granular structure; friable; few fibrous roots; few worm channels; neutral; clear smooth boundary.

A3—14 to 20 inches; black (10YR 2/1) and very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few fine faint very dark grayish brown (2.5Y 3/2) mottles; weak very fine subangular blocky structure; friable; few fibrous roots; few worm channels; neutral; clear smooth boundary.

B1—20 to 24 inches; dark gray (10YR 4/1) silty clay loam; few fine faint dark grayish brown (2.5Y 4/2) mottles; weak very fine subangular blocky structure; friable; few fibrous roots; few worm channels; neutral; clear smooth boundary.

B2g—24 to 31 inches; dark grayish brown (2.5Y 4/2) clay loam, common medium faint brown (10YR 5/3) and few fine faint strong brown (7.5YR 4/6) mottles; weak fine subangular blocky structure; friable; few fibrous roots; few worm channels; few pebbles; few fine dark accumulations of manganese and iron oxides; mildly alkaline; clear smooth boundary.

B3g—31 to 39 inches; grayish brown (2.5Y 5/2) light clay loam; common fine faint olive (5Y 5/3) and few fine distinct strong brown (7.5YR 4/6) mottles; weak medium subangular blocky structure; friable; few pebbles; few fine dark accumulations of manganese and iron oxides; mildly alkaline; clear wavy boundary.

C1g—39 to 45 inches; grayish brown (2.5Y 5/2) loam; few fine distinct strong brown (7.5Y 5/6) mottles; massive; very friable; few pebbles; slight effervescence; moderately alkaline; clear wavy boundary.

C2g—45 to 60 inches; olive gray (5Y 5/2) sandy loam; common coarse faint light olive brown (2.5Y 5/6) mottles; massive; very friable; many small pebbles; slight effervescence; mildly alkaline.

The solum is typically 30 to 40 inches in thickness. The depth to free carbonates is about the same as the solum thickness, but in some pedons the B3 horizon also contains free carbonates.

The A horizon is black (N 2/0 or 10YR 2/1) silty clay loam or clay loam. The B2g horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is typically clay loam or silty clay loam. The Cg horizon has colors similar to the B2g horizon. Some pedons, however, have chroma of 3 and value as high as 6 in part of the matrix. The Cg horizon is loam or sandy loam that has thin strata of silty or sandy material in the lower part in some pedons.

Wiota series

The Wiota series consists of well drained and moderately well drained soils on stream benches that lie a few feet above the flood plains. Permeability is moderate. These soils formed in silty alluvium. Native vegetation was prairie grasses. Slope ranges from 1 to 3 percent.

Wiota soils are similar to Judson soils and are commonly adjacent to Nevin and Bremer soils. Judson soils have thicker A horizons than Wiota soils. Nevin soils are somewhat poorly drained and are slightly lower in position. Bremer soils are poorly drained and are on low lying areas.

Typical pedon of Wiota silty clay loam, 1 to 3 percent slopes, 120 feet north and 760 feet east of the center of sec. 19, T. 84 N., R. 18 W.

Ap—0 to 8 inches; black (10YR 2/1) light silty clay loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; friable; common fibrous roots; few worm channels; slightly acid; abrupt smooth boundary.

A12—8 to 13 inches; very dark gray (10YR 3/1) light silty clay loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure parting to weak very fine granular; friable; common fibrous

roots; few worm channels; slightly acid; gradual smooth boundary.

A13—13 to 18 inches; very dark gray (10YR 3/1) light silty clay loam, very dark grayish brown (10YR 3/2) kneaded, dark grayish brown (10YR 4/2) dry; moderate very fine and fine subangular blocky structure; friable; few fibrous roots; few worm channels; slightly acid; gradual smooth boundary.

A3—18 to 26 inches; very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) silty clay loam, very dark gray (10YR 3/1) coatings on peds, brown (10YR 5/3) dry; moderate fine subangular blocky structure; friable; few fibrous roots; few worm channels; slightly acid; gradual smooth boundary.

B2t—26 to 37 inches; brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) coatings on peds; weak medium prismatic structure parting to moderate medium subangular blocky; friable; thin discontinuous clay films; few fibrous roots; few worm channels; slightly acid; gradual smooth boundary.

B3—37 to 49 inches; brown (10YR 4/3) silty clay loam; weak medium prismatic structure parting to weak medium subangular blocky; friable; thin discontinuous silt coats; few fibrous roots; few worm channels; slightly acid; gradual smooth boundary.

C—49 to 60 inches; yellowish brown (10YR 5/4) silty clay loam; few fine faint grayish brown (10YR 5/2) mottles; massive; friable; thin discontinuous silt coats; few fibrous roots; slightly acid.

The solum ranges from 36 to 60 inches in thickness. The mollic epipedon ranges from 18 to 32 inches in thickness.

The A horizon is 25 to 32 percent clay. Reaction ranges from slightly acid to strongly acid. The B horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4). The C horizon is silt loam or silty clay loam and is stratified in some pedons.

Zook series

The Zook series consists of poorly drained soils on flood plains commonly adjacent to foot slopes and bench escarpments. Permeability is slow. Zook soils formed in silty alluvium that is less than 15 percent sand. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Zook soils are similar to Colo soils and are commonly adjacent to Bremer and Nevin soils. Colo soils have less clay in the solum. Bremer soils have thinner A horizons and less clay in the B horizon. They are on second bottoms or low stream benches. Nevin soils have thinner A horizons, are somewhat poorly drained, and are on high second bottoms and low stream benches.

Typical pedon of Zook silty clay loam, 0 to 2 percent slopes, 1,040 feet south and 198 feet east of the northwest corner of sec. 20, T. 84 N., R. 18 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam, black (N 2/0) dry; weak fine granular structure; friable; common fibrous roots; neutral; abrupt smooth boundary.

A12—9 to 18 inches; black (N 2/0) heavy silty clay loam, black (N 2/0) dry; moderate very fine subangular blocky structure; friable; few fibrous roots; neutral; gradual smooth boundary.

A13—18 to 25 inches; black (N 2/0) light silty clay, black (N 2/0) dry; moderate very fine and fine subangular blocky structure; firm; few fibrous roots; slightly acid; gradual smooth boundary.

A31—25 to 32 inches; black (10YR 2/1) light silty clay, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to fine and medium subangular blocky; firm; few fibrous roots; slightly acid; gradual smooth boundary.

A32—32 to 40 inches; black (10YR 2/1) heavy silty clay loam, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to fine and medium subangular blocky; firm; few fibrous roots; slightly acid; gradual smooth boundary.

B2g—40 to 48 inches; very dark gray (10YR 3/1) silty clay loam; weak medium prismatic structure parting to weak fine subangular blocky; friable; few fibrous roots; slightly acid; gradual smooth boundary.

B3g—48 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; few fine distinct strong brown (7.5YR 5/6) mottles; weak medium prismatic structure; friable; few fibrous roots; neutral.

The solum ranges from 45 to 64 inches in thickness. The entire solum is 5 to 15 percent sand and below a depth of 16 inches, it is 38 to 46 percent clay.

The A horizon ranges from 30 to 40 inches in thickness. It is black (10YR 2/1, N 2/0) silty clay loam or silty clay. The A horizon is 32 to 42 percent clay. Reaction ranges from neutral to medium acid. The B and C horizons are very dark gray (10YR 3/1), dark gray (10YR to 5Y 4/1), gray (5Y 5/1), or grayish brown (2.5Y 5/2).

formation of the soils

This section discusses the factors of soil formation and relates these factors to the soils in Marshall County.

factors of soil formation

Soil is produced by the action of soil-forming processes on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil development have acted on the soil materials (*8*).

Climate and vegetation are the active factors in the formation of soil. They act on the parent material and slowly change it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of the parent material into a soil. It may be much or little, but some time is always required for horizon differentiation. A long period generally is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one unless conditions are specified for the other four. Many of the processes of soil development are unknown.

parent material and its geologic origin

Most of the soils in Marshall County developed from loess (windblown materials), glacial till (ice-laid materials), and alluvium (water-laid materials). A few areas of eolian sand are along the Iowa River and Minerva and Honey Creeks. Parent materials in most places are built up like layers of a cake. These layers can be observed in road cuts and in places on side slopes. In this county, parent material was important in developing the general character of the soil profile.

The major Pleistocene deposits of pre-Wisconsin age are either Kansan drift, Nebraskan drift, or both. The different drifts, or tills, are not readily differentiated in Marshall County. The glacial till ranges from none to over 300 feet in thickness.

Soils developed on the Kansan till plain during the Yarmouth and Sangamon interglacial ages. This soil development was before loess deposition. On nearly level interstream divides, the soils were strongly weathered and had a gray plastic subsoil called gumbotil. This gumbotil remains; it is several feet thick and very slowly permeable. The Clarinda soils developed in this gumbotil (*15*).

Geologic erosion has cut into and below the Yarmouth-Sangamon paleosol and into the Kansan till and older deposits. On the surface formed by this erosion, there is a stone line on top of till and erosional sediment called pedisediment. Soils that have a red clayey subsoil developed in the pedisediment, stone line, and subjacent till. This period of erosion and soil formation is called Late Sangamon. The Adair soils formed in the Late Sangamon paleosols (*9*).

The Kansan till is exposed mostly in hilly areas. The unweathered till is firm, calcareous clay loam. It contains pebbles, boulders, and sand as well as silt and clay. The soils that formed in Kansan till during the Yarmouth and Sangamon ages were covered by loess. Geologic erosion has removed the loess and paleosols on many side slopes. In these places, the till is only slightly weathered at the surface and has been exposed only during the Wisconsin State of the Quaternary period (*15*). Shelby, Gara, and Lindley soils formed in slightly weathered glacial till.

Glacial till is exposed in many rolling areas in the northeastern part of Marshall County. The till in this part of the county was truncated during the early part of loess deposition in the Wisconsin age. The truncated till surface is called the Iowan Erosion Surface (*15*).

The Iowan Erosion Surface is multi-leveled. Several levels of summits occur in a gradual progression from the stream valleys toward the low crests that mark the drainage divides. Other features typical of the Iowan Erosion Surface are erratics and paha. Erratics are large boulders partially buried or lying on the surface. Paha are prominent elongated ridges and are oriented in a distinct northwest-southeast direction. The core of the paha is an erosional remnant of the Kansan till, but the Yarmouth-Sangamon paleosol is intact (*16*). The paha are capped with thick loess or sand and loess.

The Iowan Erosion Surface is about 15 to 60 feet lower than the adjacent Kansan surface. The loess cap on the summits thins on shoulders and side slopes. Dinsdale soils formed in thin loess and glacial till.

The glacial till is less than 100 feet thick in most of the Iowan Erosion Surface areas. Geologic erosion has reworked the glacial till on hillslopes. Liscomb soils formed in loamy surface sediment and glacial till.

Loess of Wisconsin age covers most of Marshall County and is an extensive parent material. It consists mainly of silt and clay particles that have been deposited by wind. Variations in the loess are related to the distance from the source of loess. The source of loess in Marshall County is probably the bottom lands to the northwest and the Iowa River. The major deposits of loess in Marshall County are older than 14,000 years (*15*).

On the stable upland divides of the Kansan till plain, the loess is about 21 feet thick. Killduff, Tama, Muscatine, Garwin and Sperry soils are formed in loess on this landform. On the Iowan Surface, the loess is about 12 feet thick. Tama, Muscatine, Garwin, Sperry, and Harpster soils formed in loess on this landscape. Dinsdale soils formed in both loess and glacial till.

Along the rivers, loess deposits are twice as thick on both the Kansan plain and Iowan Surface. Downs, Fayette, Tama, and Killduff soils formed in this loess. Some of the high stream benches along the major streams and rivers are covered with loess deposits as thin as 7 feet. Tama, Muscatine, and Downs soils formed in this loess.

A glacial till lies above the loess in the western part of Marshall County. This till is part of the Bemis moraine system of the Des Moines Lobe. The till is of Cary age, a subdivision of the Wisconsin Glacial Stage. The evidence for the geologic youth of the Cary Glaciation is the lack of deep weathering, the unleached calcareous till at a shallow depth, the poorly developed surface drainage, and many closed depressions (*15*).

Two major erosional and depositional episodes in recent time have modified the Cary till surface. The initial relief has been reduced by the movement of material from hill summits to depressions and lowland areas. The sediment on hillslopes has selectively sorted from the summits to the toe slopes and into the depressions (*15*). Clarion, Nicollet, Webster, Canisteo, Harps, Lester, and Storden soils formed in the Cary glacial drift.

Alluvium consists of sediment that has been removed and laid down by water. As it moves, this sediment is sorted to some extent, but only in a few places is it as well sorted as the loess. Also, alluvium does not have the wide range of particle sizes that occurs in glacial drift. Because the alluvium in Marshall County is derived from loess and glacial drift, it is largely a mixture of silt and clay, silt and sand, or sand and gravel.

Alluvial sediment is the parent material for the soils on flood plains, on low benches, and in long drainageways. As the river overflows its channels and the water spreads over the flood plains, coarse textured material, such as sand and coarse silt, are deposited first. As the floodwater continues to spread, it moves more slowly, and finer textured sediment is deposited. After the flood has passed, the finest particles, or clay, settle from the water that is left standing in the lowest part of the flood plain. The Hanlon, Spillville, Nodaway, and Lawson soils commonly are closest to the stream channel and are coarser textured than the other soils on flood plains. The Ackmore, Coland, and Colo soils are on upland drainageways as well as on the flood plains of larger streams. Colo soils are extensive. Zook soils commonly are on the lower part of the bottom land and are one of the finest textured soils derived from alluvium in the county.

Alluvial stream benches are intermediate in elevation between the flood plains and the loess-covered benches. The Wiota, Nevin, Koszta, and Bremer soils formed in the silty alluvium on this landform. The Saude, Waukee, Lawler, and Hanska soils formed in loamy-over-sandy alluvium on these benches.

Sediment that has accumulated at the foot of the slope on which it originated is called colluvium or local alluvium. The Ely, Judson, Terril, and Vesser soils formed in the sediment on the foot slopes. Downslope from these soils is alluvial sediment carried in to the area from distant sources.

A secondary topographic form associated with alluvial plains is sand dunes. Fine sand is blown by the wind from stream channel and flood plain surfaces to higher elevations (*12*). Accumulations of dune sand are found on low stream benches, on high loess-covered benches, and upland fringing the leeward side of valleys. Dickinson, Sparta, and Chelsea soils are formed in eolian sand that is more than 5 feet thick.

climate

The soils in Marshall County have been developing under a midcontinental, subhumid climate for the past 5,000 years. The morphology and properties of most of the soils indicate that this climate was similar to the present climate. From 6,500 to 16,000 years ago, however, the climate probably was cool and moist and conducive mostly to the growth of forest vegetation.

The influence of the general climate in a region is modified by local conditions in or near the developing soils. For example, soils on south-facing slopes formed under a microclimate that is warmer and drier than the average climate of nearby areas. The low-lying, poorly drained soils on bottom lands formed under a wetter and colder climate than that in most areas around them. These local differences influence the characteristics of the soil and account for some of the differences among soils in the same climatic region.

vegetation and animal life

Many changes in climate and vegetation have taken place in Iowa during the past 28,000 years (*14*). The period between 28,000 to 11,000 years ago was dominated by coniferous forest with a transitional period of birch and alder. Deciduous forest dominated 11,000 to

9,000 years ago. A very dry period occurred between 9,000 to 3,200 years ago, with prairie vegetation dominating. Trees, especially oak, have invaded the prairie since 3,200 years ago, but the prairie still dominates.

For the past 5,000 years, the soils of Marshall County appear to have been influenced by two main kinds of vegetation—prairie grasses and trees. Big bluestem and little bluestem were the main prairie grasses. The main trees were deciduous, mainly oak, hickory, ash, elm, and maple.

The effects of vegetation on soils similar to those in Marshall County have been studied recently. Evidence shows that vegetation shifted while soils developed in areas bordering both trees and grasses. The morphology of the Downs, Sparta, Gara, and Lester soils reflect the influence of both trees and grasses. The Chelsea, Fayette, and Lindley soils formed under the influence of trees (*11*). Grasses influenced the development of the Tama, Muscatine, Garwin, Clarion, Colo, Dickinson, Killduff, Shelby, and Zook soils and the remaining minor soils in the county.

In most places, the soils that formed under trees are lighter colored, are more acid, and have a thinner surface layer that is lower in organic matter content than soils that formed under grasses. The soils in the county that formed under shifting vegetation or mixed grasses and trees have properties that are intermediate between the properties of soils formed under grasses and those of soils formed under trees.

Animals, such as earthworms and burrowing animals, help to keep the soil open and porous. Bacteria and fungi decompose the vegetation, thus releasing nutrients for plant food.

relief

Relief also may cause important differences among soils. It indirectly influences soil development through its effect on drainage. In Marshall County, the soils range from level to very steep. In many areas of the bottom lands, the nearly level soils are frequently flooded and have a permanently or periodically high water table. In depressions, water soaks into the nearly level soils that are subject to flooding. Much of the rainfall runs off the steep soils or uplands.

Level soils are on the broad upland flats and on the stream bottoms. The very steepest soils in the county are generally on slopes near the major streams and their tributaries. The intricate pattern of upland drainageways indicates that in most of the county the landscape has been modified by geological processes.

Generally, the soils in Marshall County that formed where the seasonal water table was well below the subsoil have a subsoil that is yellowish brown. Examples of such soils are the Clarion, Dickinson, Downs, Killduff, Shelby, and Tama soils. The Lawler, Muscatine, Nevin, and similar soils formed where the seasonal water table fluctuated and was periodically high. The Garwin, Webster, and similar soils formed where the seasonal water table is high and have a subsoil that is dominantly grayish. The Colo, Garwin, Webster, Zook and similar soils developed under prairie grasses and have a high water table. These poorly drained soils contain more organic matter in the surface layer than do well drained soils formed under prairie grasses. Clay accumulates in the subsoil of such soils as Sperry soils that are slightly depressional or nearly level. This is because a large amount of water enters the soils and carries clay particles downward. Sperry soils are called claypan soils because they have a hard layer where the greatest amount of clay accumulates.

The Killduff, Shelby, Tama, and similar soils that have wide slope ranges have some properties that change as slope increases. Two of these properties are the depth to carbonates and the thickness of the surface layer. Depth to carbonates is shallow where slopes are steepest. The surface layer becomes thin in stronger sloping soils.

time

Time is required for a soil to develop. An older and more strongly developed soil shows well defined genetic horizons. A soil with less development shows no horizons, or only weakly defined ones. Most soils on the flood plains are of this kind because these materials have not been in place long enough for distinct horizons to develop.

As an example, the effects of time can be seen by the increase of clay in the subsoil. A high clay content in the subsoil compared to that in the surface soil indicates a high degree of soil profile development has taken place. This can be important because soils with a high clay content in the subsoil generally have poorer drainage.

Material is generally removed from soils on steep slopes before there has been time for a thick profile with strong horizons to develop. Also, much of the water runs off the slopes rather than through the soil material, so that even though the material has been in place for a long time, the soil may exhibit little development.

Most of the parent materials in Marshall County are thousands of years old. The present land surface and many soils are much younger because of recent geologic erosion (*15*).

The oldest soils in Marshall County are those formed in loess on upland summits and on nearly level, loess-covered stream benches. The Garwin, Harpster, Muscatine, Sperry, and Tama soils might be as old as 14,000 years (*13*). The Clarion and other soils that formed in Cary glacial drift are as young as 3,000 years. The Liscomb and other strongly sloping soils on the Iowan Erosion Surface area are as young as or younger than 2,000 years. The Shelby and other strongly sloping or steeper soils on the Kansan till plain are as young as or younger than 6,800 years. Soils formed in alluvium

and eolian sand are only a few thousand years old or less. The Wiota, Saude, and other soils that formed in materials on stream benches are the oldest alluvial soils. The Colo, Hanlon, Spillville, and other soils that formed in materials on the flood plains are younger than Wiota and Saude soils. The Dickinson, Sparta, and Chelsea soils are of an age intermediate between Hanlon and Wiota soils. Two soils that formed in alluvium, Nodaway and Ackmore soils, are less than 125 years old.

man's influence on the soil

Important changes take place if the soil is cultivated. Some of these changes have little effect on productivity; others have a drastic effect. Changes caused by erosion generally are most apparent. On many of the cultivated soils in the county, particularly the gently rolling to hilly soils, part or all of the original surface layer has been lost through sheet erosion. In some places, shallow to deep gullies have formed.

A study of eroded soils in Iowa, including Marshall County, was started in 1974 by the Iowa Cooperative Soil Survey. Soil descriptions and laboratory data of selected sites are available. Initial results show a lower organic matter content in eroded soils.

Nodaway and Ackmore soils formed in stratified silt loam alluvium on alluvial fans and flood plains. This alluvium has been deposited on the bottom during the past 125 years of cultivation. Many sloping soils have lost topsoil through water erosion to form these recent flood plain deposits. About 23 percent of the soils in Marshall County are eroded.

In many continuously cultivated fields, the granular structure that was apparent when the grassland was undisturbed is no longer present. In these fields the surface tends to bake and harden when it dries. Fine textured soils that have been plowed when too wet tend to puddle and are less permeable than similar soils in undisturbed areas. Poor seedling emergence and root penetration result in these areas.

Man has done much to increase the productivity of the soils and to reclaim areas not suitable for crops. He has made large areas of bottom land suitable for cultivation by digging drainage ditches and constructing diversions and dikes. Broad flats and nearly level soils, such as Garwin and Webster soils, have been greatly improved for cultivation by installing some kind of drainage system. By adding commercial fertilizers, man has counteracted deficiencies in plant nutrients and has made some soils more productive than they were in their natural state.

processes of horizon differentiation

Horizon differentiation is caused by four basic kinds of change—additions, removals, transfers, and transformation in the soil system (*18*). Each of these four kinds of change affects many substances that compose soils, such as organic matter, soluble salts, carbonates, sesquioxides, or silicate clay materials. In general, these processes tend to promote horizon differentiation, but some tend to offset or retard it. These processes and the changes brought about proceed simultaneously in soils, and the ultimate nature of the profile is governed by the balance of these changes within the profile.

An accumulation of organic matter is an early step in the process of horizon differentiation in most soils. Soils in Marshall County range from very high to very low in the amount of organic matter that has accumulated in their surface layers. Some soils that were formerly quite high in organic matter content are now low because of erosion. The accumulation of organic matter has been an important process in the differentiation of soil horizons in Marshall County.

The process through which substances are removed from parts of the soil profile is important in the differentiation of soil horizons. The movement of calcium carbonates and bases downward in soils is an example. All the soils in the county, except Canisteo, Harps, Harpster, and Storden soils, have been leached free of calcium carbonates in the upper part of their profile. Some soils have been so strongly leached that they are strongly acid or very strongly acid even in their subsoil.

Phosphorus is removed from the subsoil by plant roots and transferred to other parts of the plant. It is then returned to the surface layer in the plant residue. These processes affect the forms and distribution of phosphorus in the profile.

The translocation of silicate clay minerals is another important process. The clay minerals are carried downward in suspension in percolating water from the surface layer. They accumulate in the subsoil in pores and root channels and as clay films. In Marshall County, this process has had an influence on the profiles of many of the soils. In other soils, the clay content of the horizons are not markedly different and other evidence of clay movement is minimal.

Another kind of transfer that is minimal in most soils, but occurs to some extent in very clayey soils, is that brought about by shrinking and swelling. This causes cracks to form and incorporates some material from the surface layer into lower parts of the profile. Clarinda soils are examples of soils with potential for this kind of physical transfer.

Transformations are physical and chemical. For example, soil particles are weathered to smaller sizes. The reduction of iron is another example of a transformation. This process is called gleying and involves the saturation of the soil with water for long periods in the presence of organic matter. It is characterized by the presence of ferrous iron and gray colors. Gleying is associated with poorly drained soils, such as the Garwin soils. Reductive extractable iron, or free iron, is normally lower in somewhat poorly drained soils, such as Muscatine soils (*20*). Still another kind of transformation is the weathering of the primary apatite mineral present in soil parent materials to secondary phosphorous compounds.

geologic profile of Marshall County

Marshall County has a gently undulating to rolling and steep landscape. It is mainly dissected by the Iowa River and the North Skunk River. Clear Creek, the three Timber Creeks, Linn Creek and three Minerva Creeks, and the two Asher Creeks are the principal interior streams (*4*).

The broad upland areas are dominated by loess at the surface. The soils formed in loess, such as the Muscatine and Tama soils, are the most productive soils in Marshall County and in Iowa. Strongly sloping to steep soils, such as the Shelby soils, formed in glacial till and till-derived materials. These soils are on slopes that descend to the major streams. Along the bottom of the streams are complex patterns of alluvium and related areas of wind-reworked sands. In the western part of the county are Clarion soils formed in Wisconsin glacial till.

Although the unconsolidated materials dominate the present land surface, such bedrock as limestone and sandstone is exposed locally. All the bedrock material would be exposed if the unconsolidated materials were removed. However, the surface exposed would not be flat but would exhibit landforms much like the present surface. There are bedrock valleys and ridges which can affect water movement within the overlying unconsolidated materials.

Bedrock is exposed in about 21 different sections in Marshall County. In most places the natural outcrops are small. The bedrock exposed in Marshall County is primarily of Mississippian and Pennsylvanian age (*7*). The general rock types are mostly dolomite and sandstone. The dolomite is quarried and provides stone for aggregate, road surfacing, and agstone. Some coal measure shales are exposed by Honey Creek.

Information collected during the drilling of wells and test holes is available for over 180 wells in Marshall County (*6*). Detailed information is available for many of these wells. Some of these wells are drilled into rocks that are aquifers. Three distinct levels of rocks that are aquifers occur in Marshall County (*5*).

references

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Battin, J. W. and F. A. Moscrip. 1912. Past and present of Marshall County, Iowa. B. F. Bowen & Co., Indianapolis. vol. 1, 672 pp.

(4) Beyer, Samuel W. 1897. Geology of Marshall County. Iowa Geol. Surv. Ann. Rep. 7:197-262.

(5) Cable, R. W. and F. R. Twenter. 1965. The water story in central Iowa. Iowa Geol. Surv. Water Atlas Bull., 89 pp., illus.

(6) Gockel, D. J. 1976. Selected geologic information from drill holes in northeastern Iowa. Iowa Geol. Surv. Tech. Inf. Series Bull. 2, 109 pp.

(7) Hershey, H. Garland. 1969. Bedrock of Iowa. Iowa Geol. Surv. Map.

(8) Jenny, Hans. 1941. Factors of soil formation. McGraw-Hill Book Company, Inc., 281 pp., illus.

(9) Lane, G. H. 1941. Pollen analysis of Interglacial Peats of Iowa. Iowa Geol. Surv. Ann. Rep. 37: 237-260, illus.

(10) Meyer, A. H. and E. I. Angell. 1921. Soil survey of Marshall County, Iowa. U. S. Dep. Agric., Bureau of Soils.

(11) Prill, R. C. and F. F. Riecken. 1958. Variations in forest derived soils formed in Kansan till in southern and southeastern Iowa. Soil Sci. Soc. Am. Proc. 22: 70-75, illus.

(12) Prior, J. C. 1976. A regional guide to Iowa landforms. Iowa Geol. Surv. Educ. Series Bull. 3, 72 pp., illus.

(13) Ruhe, Robert V. 1956. Ages and development of soil landscapes in relation to climatic and vegetational changes in Iowa. Soil Sci. Soc. Am. Proc. 20: 264-273, illus.

(14) Ruhe, Robert V. 1956. Geomorphic surfaces and the nature of soils. Soil Sci. 82: 441-445, illus.

(15) Ruhe, Robert V. 1969. Quaternary landscapes in Iowa. Iowa State Univ. Press, 255 pp., illus.

(16) Ruhe, R. V., W. P. Dietz, T. E. Fenton, and G. F. Hall. 1968. Iowan drift problem of northeastern Iowa. Iowa Geol. Surv. Rep. Invest. 7, pp. 1-40, illus.

(17) Shultz, Gerard. 1955. History of Marshall County. Gerard Shultz, Marshalltown. 244 pp.

(18) Simonson, Roy W. 1959. Outline of a generalized theory of soil genesis. Soil. Sci. Soc. Am. Proc. 23: 152-156, illus.

(19) United States Department of Agriculture. 1951. Soil survey manual. U. S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]

(20) United States Department of Agriculture. 1967. Soil survey laboratory methods and procedures for collecting soil samples. Soil Surv. Invest. Rep. 1, 50 pp., illus.

(21) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U. S. Dep. Agric. Handb. 436, 754 pp., illus.

(22) Western Historical Company. 1878. The history of Marshall County, Iowa. Western Historical Co., Chicago. (Reprinted by Unigraphic Inc., Portland, Ind. 1974.) 696 pp., illus.

glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on a contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bottom land. The normal flood plain of a stream, subject to flooding.

Broad-base terrace. A ridge-type terrace built to control erosion by diverting runoff along the contour at a nonscouring velocity. The terrace is 10 to 20 inches high and 15 to 30 feet wide and has gently sloping sides, a rounded crown, and a dish-shaped channel along the upper side. It may be nearly level or have a grade toward one or both ends.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected

scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or arresting grazing for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils

are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Gumbotil. Leached, deoxidized clay; the product of thorough chemical decomposition of clay-rich glacial till.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual.* The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected

by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Paleosol. A buried soil or formerly buried soil, especially one that formed during an interglacial period.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedisediment. Water-sorted sediment at the top of a paleosol.

Pedon. The smallest volume that can be called "a soil. A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability

is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor filter (in tables). Because of rapid permeability or an impermeable layer near the surface, the soil may not adequately filter effluent from a waste disposal system.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then

multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A1, A2, or A3) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A horizon. It includes all subdivisions of this horizon (A1, A2, and A3).

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-73 at Marshalltown, Iowa]

Month	Temperature: Average daily maximum	Temperature: Average daily minimum	Temperature: Average daily	Temperature: 2 years in 10 will have-- Maximum temperature higher than--	Temperature: 2 years in 10 will have-- Minimum temperature lower than--	Temperature: Average number of growing degree days[1]	Precipitation: Average	Precipitation: 2 years in 10 will have-- Less than--	Precipitation: 2 years in 10 will have-- More than--	Precipitation: Average number of days with 0.10 inch or more	Precipitation: Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	27.5	8.0	17.8	53	-22	0	.95	.32	1.44	3	6.4
February---	33.5	13.8	23.7	57	-20	0	1.18	.32	1.86	4	7.6
March------	43.3	23.8	33.6	78	-5	28	2.44	1.19	3.46	6	8.5
April------	60.2	37.6	48.9	87	19	78	3.29	2.11	4.35	7	1.1
May--------	72.0	48.9	60.5	90	29	337	4.47	2.55	6.03	8	.0
June-------	81.6	58.8	70.2	97	42	606	4.64	2.08	6.72	7	.0
July-------	84.8	62.4	73.6	98	47	732	4.32	1.66	6.46	7	.0
August-----	83.1	59.9	71.5	96	44	667	3.76	1.90	5.27	6	.0
September--	74.8	50.6	62.8	93	31	384	3.37	1.29	5.04	6	.0
October----	64.8	40.7	52.8	87	19	177	2.10	.45	3.38	5	.1
November---	47.0	27.2	37.1	71	1	10	1.43	.33	2.29	3	2.1
December---	33.0	15.6	24.3	60	-18	0	1.15	.50	1.67	3	6.8
Yearly:											
Average--	58.8	37.3	48.1	---	---	---	---	---	---	---	---
Extreme--	---	---	---	99	-24	---	---	---	---	---	---
Total----	---	---	---	---	---	3,019	33.10	26.97	38.93	65	32.6

[1]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-73 at Marshalltown, Iowa]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 20	April 27	May 14
2 years in 10 later than--	April 15	April 23	May 9
5 years in 10 later than--	April 7	April 15	April 30
First freezing temperature in fall:			
1 year in 10 earlier than--	October 17	October 2	September 19
2 years in 10 earlier than--	October 21	October 7	September 24
5 years in 10 earlier than--	October 28	October 15	October 4

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-73 at Marshalltown, Iowa]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	188	163	139
8 years in 10	193	170	145
5 years in 10	203	182	157
2 years in 10	213	195	168
1 year in 10	219	202	174

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
5B	Ackmore-Colo complex, 2 to 5 percent slopes	6,250	1.7
6	Okoboji silty clay loam, 0 to 1 percent slopes	675	0.2
7	Wiota silty clay loam, 1 to 3 percent slopes	1,085	0.3
8B	Judson silty clay loam, 2 to 5 percent slopes	1,200	0.3
8C	Judson silty clay loam, 5 to 9 percent slopes	865	0.2
11B	Colo-Ely complex, 2 to 5 percent slopes	20,750	5.6
20C2	Killduff silty clay loam, 5 to 9 percent slopes, moderately eroded	11,785	3.2
20D2	Killduff silty clay loam, 9 to 14 percent slopes, moderately eroded	25,075	6.8
20D3	Killduff silty clay loam, 9 to 14 percent slopes, severely eroded	3,900	1.1
20E2	Killduff silty clay loam, 14 to 18 percent slopes, moderately eroded	1,020	0.3
20E3	Killduff silty clay loam, 14 to 18 percent slopes, severely eroded	1,295	0.4
24D2	Shelby loam, 9 to 14 percent slopes, moderately eroded	3,175	0.9
24D3	Shelby clay loam, 9 to 14 percent slopes, severely eroded	220	0.1
24E2	Shelby loam, 14 to 18 percent slopes, moderately eroded	4,700	1.3
24E3	Shelby clay loam, 14 to 18 percent slopes, severely eroded	625	0.2
24F2	Shelby loam, 18 to 25 percent slopes, moderately eroded	1,055	0.3
41B	Sparta loamy fine sand, 2 to 5 percent slopes	230	0.1
41C	Sparta loamy fine sand, 5 to 9 percent slopes	605	0.2
41D	Sparta loamy fine sand, 9 to 14 percent slopes	220	0.1
43	Bremer silty clay loam, 0 to 2 percent slopes	1,000	0.3
51	Vesser silt loam, 0 to 2 percent slopes	255	0.1
54	Zook silty clay loam, 0 to 2 percent slopes	3,300	0.9
55	Nicollet loam, 1 to 3 percent slopes	5,350	1.5
62D2	Storden loam, 9 to 14 percent slopes, moderately eroded	665	0.2
63C	Chelsea loamy fine sand, 5 to 9 percent slopes	275	0.1
63E	Chelsea loamy fine sand, 9 to 18 percent slopes	185	*
65F	Lindley loam, 18 to 25 percent slopes	495	0.1
65G	Lindley loam, 25 to 40 percent slopes	805	0.2
88	Nevin silty clay loam, 1 to 3 percent slopes	1,300	0.4
93D2	Shelby-Adair complex, 9 to 14 percent slopes, moderately eroded	500	0.1
93E2	Shelby-Adair complex, 14 to 18 percent slopes, moderately eroded	920	0.3
95	Harps loam, 0 to 2 percent slopes	295	0.1
107	Webster silty clay loam, 0 to 2 percent slopes	3,625	1.0
118	Garwin silty clay loam, 0 to 2 percent slopes	7,425	2.0
119	Muscatine silty clay loam, 1 to 3 percent slopes	28,075	7.6
120	Tama silty clay loam, 0 to 2 percent slopes	6,725	1.8
120B	Tama silty clay loam, 2 to 5 percent slopes	54,360	14.8
120C	Tama silty clay loam, 5 to 9 percent slopes	21,170	5.8
120C2	Tama silty clay loam, 5 to 9 percent slopes, moderately eroded	38,550	10.5
120D2	Tama silty clay loam, 9 to 14 percent slopes, moderately eroded	19,200	5.2
120E2	Tama silty clay loam, 14 to 18 percent slopes, moderately eroded	1,305	0.4
122	Sperry silt loam, 0 to 2 percent slopes	475	0.1
133	Colo silty clay loam, 0 to 2 percent slopes	3,750	1.0
133+	Colo silt loam, 0 to 2 percent slopes	3,225	0.9
133B	Colo silty clay loam, 2 to 5 percent slopes	1,825	0.5
135	Coland silty clay loam, 0 to 2 percent slopes	1,455	0.4
138B	Clarion loam, 2 to 5 percent slopes	3,950	1.1
138C	Clarion loam, 5 to 9 percent slopes	2,725	0.7
138C2	Clarion loam, 5 to 9 percent slopes, moderately eroded	2,650	0.7
138D2	Clarion loam, 9 to 14 percent slopes, moderately eroded	1,900	0.5
138E2	Clarion loam, 14 to 18 percent slopes, moderately eroded	435	0.1
150	Hanska loam, 0 to 2 percent slopes	470	0.1
162B	Downs silt loam, 2 to 5 percent slopes	1,005	0.3
162C	Downs silt loam, 5 to 9 percent slopes	1,325	0.4
162C2	Downs silt loam, 5 to 9 percent slopes, moderately eroded	2,000	0.5
162D	Downs silt loam, 9 to 14 percent slopes	785	0.2
162D2	Downs silt loam, 9 to 14 percent slopes, moderately eroded	1,950	0.5
162E2	Downs silt loam, 14 to 18 percent slopes, moderately eroded	1,350	0.4
163B	Fayette silt loam, 2 to 5 percent slopes	265	0.1
163C	Fayette silt loam, 5 to 9 percent slopes	350	0.1
163D	Fayette silt loam, 9 to 14 percent slopes	450	0.1
163E	Fayette silt loam, 14 to 18 percent slopes	355	0.1
163F	Fayette silt loam, 18 to 25 percent slopes	535	0.1
175B	Dickinson fine sandy loam, 2 to 5 percent slopes	555	0.1
175C	Dickinson fine sandy loam, 5 to 9 percent slopes	635	0.2
175D2	Dickinson fine sandy loam, 9 to 14 percent slopes, moderately eroded	205	*
177	Saude loam, 1 to 3 percent slopes	955	0.3
177C2	Saude loam, 5 to 9 percent slopes, moderately eroded	390	0.1
178	Waukee loam, 1 to 3 percent slopes	1,295	0.4
179E	Gara loam, 14 to 18 percent slopes	340	0.1
179E2	Gara loam, 14 to 18 percent slopes, moderately eroded	670	0.2
179F	Gara loam, 18 to 25 percent slopes	840	0.2

See footnote at end of table.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
192D2	Adair clay loam, 9 to 14 percent slopes, moderately eroded	710	0.2
201B	Coland-Terril complex, 2 to 5 percent slopes	2,375	0.6
220	Nodaway silt loam, 0 to 2 percent slopes	4,125	1.1
222D2	Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded	1,155	0.3
226	Lawler loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	1,785	0.5
236C	Lester loam, 5 to 9 percent slopes	215	0.1
236C2	Lester loam, 5 to 9 percent slopes, moderately eroded	215	0.1
236D2	Lester loam, 9 to 14 percent slopes, moderately eroded	235	0.1
236E	Lester loam, 14 to 18 percent slopes	215	0.1
236F	Lester loam, 18 to 25 percent slopes	305	0.1
323C	Terril loam, sandy substratum, 5 to 9 percent slopes	350	0.1
377C	Dinsdale silty clay loam, 5 to 9 percent slopes	365	0.1
377C2	Dinsdale silty clay loam, 5 to 9 percent slopes, moderately eroded	1,700	0.5
377D2	Dinsdale silty clay loam, 9 to 14 percent slopes, moderately eroded	1,650	0.4
420B	Tama silty clay loam, benches, 2 to 5 percent slopes	1,055	0.3
420C2	Tama silty clay loam, benches, 5 to 9 percent slopes, moderately eroded	455	0.1
428B	Ely silty clay loam, 2 to 5 percent slopes	1,565	0.4
430	Ackmore silt loam, 0 to 2 percent slopes	3,975	1.1
442B	Dickinson-Sparta-Tama complex, 2 to 5 percent slopes	440	0.1
442C2	Dickinson-Sparta-Tama complex, 5 to 12 percent slopes, moderately eroded	1,260	0.3
442E2	Dickinson-Sparta-Tama complex, 12 to 18 percent slopes, moderately eroded	550	0.1
462B	Downs silt loam, benches, 2 to 5 percent slopes	440	0.1
484	Lawson silty clay loam, 0 to 2 percent slopes	3,475	0.9
485	Spillville loam, 0 to 2 percent slopes	620	0.2
507	Canisteo silty clay loam, 0 to 2 percent slopes	530	0.1
536	Hanlon fine sandy loam, 0 to 2 percent slopes	275	0.1
595	Harpster silty clay loam, 0 to 2 percent slopes	360	0.1
683C2	Liscomb loam, 5 to 9 percent slopes, moderately eroded	235	0.1
683D	Liscomb loam, 9 to 14 percent slopes	395	0.1
683D2	Liscomb loam, 9 to 14 percent slopes, moderately eroded	1,775	0.5
683E	Liscomb loam, 14 to 18 percent slopes	205	*
683E2	Liscomb loam, 14 to 18 percent slopes, moderately eroded	645	0.2
688	Koszta silt loam, 1 to 3 percent slopes	525	0.1
1133	Colo silty clay loam, channeled, 0 to 2 percent slopes	395	0.1
1220	Nodaway silt loam, channeled, 0 to 2 percent slopes	1,485	0.4
1485	Spillville loam, channeled, 0 to 2 percent slopes	1,610	0.4
1936	Colo-Hanlon-Lawson complex, channeled, 0 to 2 percent slopes	5,650	1.5
4011B	Colo-Ely-Urban land complex, 2 to 5 percent slopes	290	0.1
4119	Muscatine-Urban land complex, 1 to 3 percent slopes	190	*
4120B	Tama-Urban land complex, 2 to 5 percent slopes	1,295	0.4
4120C	Tama-Urban land complex, 5 to 9 percent slopes	915	0.2
4133	Colo-Urban land complex, 0 to 2 percent slopes	310	0.1
5010	Pits, sand and gravel	485	0.1
5030	Pits, limestone quarry	230	0.1
	Water	700	0.2
	Total	367,360	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
5B-------------------------- Ackmore-Colo	106	40	65	4.2	4.0	5.8	7.0
6--------------------------- Okoboji	84	32	67	3.4	3.3	4.3	7.3
7--------------------------- Wiota	108	41	59	4.5	4.0	6.4	7.5
8B-------------------------- Judson	124	47	93	5.2	4.2	7.3	8.6
8C-------------------------- Judson	119	45	90	5.0	4.1	7.1	8.3
11B------------------------- Colo-Ely	111	42	83	4.6	4.1	6.2	7.5
20C2------------------------ Killduff	115	43	86	4.9	3.8	7.0	8.1
20D2------------------------ Killduff	106	40	79	4.5	3.5	6.3	7.5
20D3------------------------ Killduff	100	39	74	4.2	3.2	5.9	7.2
20E2------------------------ Killduff	91	34	67	3.9	3.3	5.3	6.5
20E3------------------------ Killduff	85	33	63	3.6	3.1	4.8	6.2
24D2------------------------ Shelby	81	31	44	3.4	3.3	4.9	5.6
24D3------------------------ Shelby	75	29	41	3.2	2.7	4.5	5.3
24E2------------------------ Shelby	66	25	36	2.7	2.1	4.0	4.5
24E3------------------------ Shelby	60	23	33	2.5	1.7	3.6	4.2
24F2------------------------ Shelby	---	---	---	---	1.7	2.7	3.1
41B------------------------- Sparta	50	23	40	2.5	2.0	3.7	4.3
41C, 41D-------------------- Sparta	40	21	36	2.3	2.0	2.9	3.8
43-------------------------- Bremer	106	40	58	4.5	4.0	6.3	7.5
51-------------------------- Vesser	95	36	52	4.0	3.7	5.0	5.6
54-------------------------- Zook	96	36	72	4.0	4.0	4.0	4.5

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
55 Nicollet	125	40	84	4.9	3.5	5.3	6.5
62D2 Storden	75	22	50	3.5	3.0	4.1	5.0
63C Chelsea	52	20	39	1.8	1.8	3.0	3.0
63E Chelsea	---	---	35	1.5	1.5	2.5	2.5
65F, 65G Lindley	---	---	---	1.2	1.8	2.0	2.0
88 Nevin	114	43	63	4.8	4.0	8.0	8.0
93D2 Shelby-Adair	68	25	37	2.9	2.6	4.0	4.8
93E2 Shelby-Adair	60	23	32	2.3	1.9	3.3	3.9
95 Harps	95	36	76	4.0	3.3	5.0	6.6
107 Webster	110	42	88	4.4	4.2	6.6	7.3
118 Garwin	125	47	94	5.0	4.1	7.5	8.3
119 Muscatine	131	50	98	5.5	4.2	7.8	9.1
120 Tama	127	49	95	5.3	4.2	7.6	8.6
120B Tama	125	48	95	5.2	4.2	7.5	8.6
120C Tama	120	46	90	5.0	4.0	7.1	8.3
120C2 Tama	117	44	88	4.9	3.8	7.0	8.1
120D2 Tama	108	41	81	4.5	3.3	6.3	7.5
120E2 Tama	93	35	70	3.9	3.0	5.5	6.5
122 Sperry	90	34	48	3.3	3.6	5.1	5.8
133 Colo	104	40	78	4.2	4.2	5.5	7.0
133+ Colo	109	42	78	4.3	4.2	5.8	7.0
133B Colo	102	39	76	4.0	4.2	5.3	6.6
135 Coland	105	42	80	4.3	4.1	6.0	7.6

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
138B Clarion	110	42	88	4.6	4.2	6.7	7.6
138C Clarion	105	40	84	4.4	3.8	6.3	7.3
138C2 Clarion	102	39	82	4.3	3.8	6.2	7.1
138D2 Clarion	93	35	74	3.9	3.7	5.5	6.5
138E2 Clarion	78	30	60	3.3	3.0	4.7	5.5
150 Hanska	70	28	56	3.2	3.3	4.1	5.2
162B Downs	119	45	95	5.0	4.1	7.1	8.3
162C Downs	114	43	91	4.8	4.0	6.8	8.1
162C2 Downs	111	42	89	4.7	3.8	6.6	7.8
162D Downs	105	40	84	4.4	3.8	6.3	7.3
162D2 Downs	102	39	82	4.3	3.6	6.1	7.1
162E2 Downs	87	33	69	3.7	3.5	5.1	6.1
163B Fayette	113	43	90	4.7	4.0	6.6	7.8
163C Fayette	108	41	86	4.5	3.8	6.5	7.5
163D Fayette	99	38	80	4.2	3.6	6.0	7.0
163E Fayette	84	32	67	3.5	3.3	5.0	5.8
163F Fayette	---	---	60	3.4	3.1	4.8	5.6
175B Dickinson	81	31	60	3.0	2.7	4.8	5.0
175C Dickinson	76	29	57	2.8	2.5	4.5	4.6
175D2 Dickinson	65	25	48	2.0	1.8	3.8	3.3
177 Saude	78	30	62	3.3	3.0	4.6	5.5
177C2 Saude	68	26	54	2.8	2.7	4.1	4.6
178 Waukee	98	37	78	4.1	4.0	5.8	6.8

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
179E------ Gara	---	---	---	2.5	1.7	3.3	4.1
179E2------ Gara	---	---	---	2.2	1.5	2.9	3.8
179F------ Gara	---	---	---	1.5	1.3	2.0	2.5
192D2------ Adair	54	20	30	2.3	1.9	2.9	3.8
201B------ Coland-Terril	110	41	62	4.7	3.3	6.2	7.8
220------ Nodaway	110	42	60	4.6	4.0	6.5	7.6
222D2------ Clarinda	46	17	25	1.8	1.7	2.9	3.0
226------ Lawler	100	38	80	4.2	4.0	6.0	7.0
236C------ Lester	95	33	75	4.5	3.5	5.5	6.5
236C2, 236D2------ Lester	90	31	70	4.3	3.3	5.3	6.3
236E------ Lester	75	30	65	4.0	3.0	4.9	6.0
236F------ Lester	---	---	---	3.0	3.0	3.8	4.5
323C------ Terril	113	43	91	4.8	4.2	6.7	8.0
377C------ Dinsdale	114	43	85	4.8	4.0	6.8	8.0
377C2------ Dinsdale	111	42	83	4.6	3.8	6.6	7.6
377D2------ Dinsdale	102	39	76	4.4	3.6	6.1	7.3
420B------ Tama	125	48	95	5.2	4.2	7.5	8.6
420C2------ Tama	117	44	88	4.9	3.8	7.0	8.1
428B------ Ely	124	47	93	5.3	4.0	7.5	8.8
430------ Ackmore	106	40	58	4.5	3.8	6.3	7.5
442B------ Dickinson-Sparta-Tama	82	30	61	3.3	2.8	5.0	6.1
442C2------ Dickinson-Sparta-Tama	75	28	55	3.6	2.5	4.9	6.0
442E2------ Dickinson-Sparta-Tama	---	---	---	---	1.6	3.8	4.7

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
462B Downs	119	45	95	5.0	4.1	7.1	8.3
484 Lawson	110	42	80	4.0	3.5	7.0	8.1
485 Spillville	122	46	98	5.1	4.2	7.3	8.6
507 Canisteo	110	36	75	3.5	3.0	4.1	5.2
536 Hanlon	90	34	72	3.8	3.3	5.3	6.3
595 Harpster	115	44	74	5.0	4.1	6.1	8.3
683C2 Liscomb	95	36	66	4.0	3.4	5.7	6.6
683D Liscomb	91	34	63	3.8	3.3	5.4	6.3
683D2 Liscomb	88	32	61	3.6	3.1	5.2	6.0
683E Liscomb	75	28	53	3.2	2.7	4.5	5.3
683E2 Liscomb	72	26	50	3.0	2.5	4.3	5.0
688 Koszta	108	41	59	4.5	3.7	6.5	7.5
1133 Colo	---	---	---	---	3.0	---	---
1220 Nodaway	---	---	---	---	4.0	---	---
1485 Spillville	---	---	---	---	3.8	---	---
1936 Colo-Hanlon-Lawson	---	---	---	---	3.1	---	---
4011B Colo-Ely-Urban land	---	---	---	---	---	---	---
4119 Muscatine-Urban land	---	---	---	---	---	---	---
4120B Tama-Urban land	---	---	---	---	---	---	---
4120C Tama-Urban land	---	---	---	---	---	---	---
4133 Colo-Urban land	---	---	---	---	---	---	---
5010**, 5030**. Pits							

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.
** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--CAPABILITY CLASSES AND SUBCLASSES

[Miscellaneous areas are excluded. Absence of an entry indicates no acreage]

Class	Total acreage	Major management concerns (Subclass)		
		Erosion (e)	Wetness (w)	Soil problem (s)
		Acres	Acres	Acres
I	43,777	---	---	---
II	139,587	74,075	62,772	2,740
III	147,519	146,369	1,150	---
IV	14,450	13,849	---	601
V	8,241	---	8,241	---
VI	6,495	5,019	---	1,476
VII	1,476	1,300	---	176
VIII	---	---	---	---

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Potential productivity: Common trees	Site index	Trees to plant
5B*:								
Ackmore	2o	Slight	Slight	Slight	Slight	White oak	65	Eastern white pine, red pine, black walnut, sugar maple, poplar.
Colo.								
41B, 41C, 41D Sparta	2s	Slight	Slight	Severe	Slight	Northern red oak	70	Eastern white pine, red pine, jack pine.
						Red pine	---	
						Eastern white pine	---	
						Jack pine	---	
43 Bremer	3w	Slight	Severe	Moderate	Moderate	Eastern cottonwood	90	American sycamore, common hackberry, green ash, eastern cottonwood, silver maple, northern white-cedar.
						Silver maple	80	
63C, 63E Chelsea	2s	Slight	Slight	Moderate	Slight	White oak	70	Eastern white pine, red pine, jack pine.
						Red pine	72	
						Eastern white pine	83	
						Jack pine	70	
						Quaking aspen	72	
						Northern red oak	70	
65F, 65G Lindley	3r	Moderate	Moderate	Slight	Slight	White oak	60	White oak, green ash, yellow-poplar.
162B, 162C, 162C2, 162D, 162D2 Downs	1o	Slight	Slight	Slight	Slight	White oak	80	Eastern white pine, northern red oak, green ash, yellow-poplar.
						Northern red oak	80	
						Yellow-poplar	90	
						Black walnut	---	
162E2 Downs	1r	Moderate	Moderate	Slight	Slight	White oak	80	Eastern white pine, northern red oak, green ash, yellow-poplar.
						Northern red oak	80	
						Yellow-poplar	90	
						Black walnut	---	
163B, 163C, 163D Fayette	1o	Slight	Slight	Slight	Slight	White oak	80	Eastern white pine, northern red oak, green ash, yellow-poplar.
						Northern red oak	80	
						Yellow-poplar	90	
						Black walnut	---	
163E, 163F Fayette	1r	Moderate	Moderate	Slight	Slight	White oak	80	Eastern white pine, northern red oak, green ash, Scotch pine, yellow-poplar.
						Northern red oak	80	
						Yellow-poplar	90	
						Black walnut	---	
179E, 179E2, 179F Gara	3r	Moderate	Moderate	Slight	Slight	White oak	55	Eastern white pine, red pine.
						Northern red oak	55	
220 Nodaway	2o	Slight	Slight	Slight	Slight	White oak	65	Eastern white pine, red pine, black walnut, sugar maple.
236C, 236C2, 236D2 Lester	2o	Slight	Slight	Slight	Slight	Northern red oak	69	Black walnut, northern red oak, American basswood, silver maple, white oak.
						American basswood	69	
						Black walnut	62	
						Eastern cottonwood	92	
						Eastern white pine	64	
						White oak	62	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
236E, 236F--------- Lester	2r	Moderate	Moderate	Slight	Slight	Northern red oak---- American basswood--- Black walnut-------- Eastern cottonwood-- Eastern white pine-- White oak-----------	69 69 62 92 64 62	Black walnut, northern red oak, American basswood, silver maple, white oak.
430---------------- Ackmore	2o	Slight	Slight	Slight	Slight	White oak-----------	65	Eastern white pine, red pine, European larch, black walnut, sugar maple, poplar.
442B*, 442C2*, 442E2*: Dickinson.								
Sparta-----------	2s	Slight	Slight	Severe	Slight	Northern red oak---- Red pine------------ Eastern white pine-- Jack pine-----------	70 --- --- ---	Eastern white pine, red pine, jack pine.
Tama.								
462B--------------- Downs	1o	Slight	Slight	Slight	Slight	White oak----------- Northern red oak---- Yellow-poplar------- Black walnut--------	80 80 90 ---	Eastern white pine, northern red oak, green ash, yellow-poplar.
536---------------- Hanlon	3o	Slight	Slight	Slight	Slight	Northern red oak---- White oak-----------	55 55	Eastern white pine, red pine, black walnut, sugar maple.
688---------------- Koszta	2o	Slight	Slight	Slight	Slight	White oak----------- Northern red oak----	65 70	Eastern white pine, red pine, white oak, northern red oak, sugar maple.
1220--------------- Nodaway	2o	Slight	Slight	Slight	Slight	White oak-----------	65	Eastern white pine, red pine, black walnut, sugar maple.
1936*: Colo.								
Hanlon------------	3o	Slight	Slight	Slight	Slight	Northern red oak---- White oak-----------	55 55	Eastern white pine, red pine, black walnut, sugar maple.
Lawson.								

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
5B*:					
Ackmore	Silky dogwood, gray dogwood.	Redosier dogwood, Tatarian honeysuckle, lilac.	Amur maple, eastern redcedar.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
Colo	Gray dogwood, silky dogwood.	Tatarian honeysuckle, redosier dogwood, Zabel honeysuckle.	Laurel willow, white spruce, Amur maple, northern white-cedar.	Green ash	Silver maple, eastern cottonwood.
6 Okoboji	Common ninebark, redosier dogwood.	Tatarian honeysuckle, silky dogwood, autumn-olive.	Norway spruce, Amur maple, Zabel honeysuckle, northern white-cedar.	Green ash	Silver maple, eastern cottonwood.
7 Wiota	Gray dogwood, silky dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
8B, 8C Judson	Gray dogwood, silky dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Green ash, red pine, Norway spruce.	Silver maple, eastern cottonwood.
11B*:					
Colo	Gray dogwood, silky dogwood.	Tatarian honeysuckle, redosier dogwood, Zabel honeysuckle.	Laurel willow, white spruce, Amur maple, northern white-cedar.	Green ash	Silver maple, eastern cottonwood.
Ely	Gray dogwood, silky dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
20C2, 20D2, 20D3, 20E2, 20E3 Killduff	Gray dogwood, silky dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern white pine, silver maple.
24D2, 24D3, 24E2, 24E3, 24F2 Shelby	Silky dogwood, gray dogwood.	Tatarian honeysuckle, lilac, redosier dogwood.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern white pine, silver maple.
41B, 41C, 41D Sparta	Siberian peashrub	Eastern redcedar, lilac, autumn-olive, Tatarian honeysuckle, Amur honeysuckle.	Austrian pine, Russian-olive.	Eastern white pine, red pine, jack pine, ponderosa pine.	---
43 Bremer	Silky dogwood, gray dogwood.	Redosier dogwood, Tatarian honeysuckle, American plum, Zabel honeysuckle.	Laurel willow, northern white-cedar, Amur maple.	Green ash	Eastern cottonwood, silver maple.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
51. Vesser	Silky dogwood	Redosier dogwood, American plum, Tatarian honeysuckle, eastern redcedar, Zabel honeysuckle.	Amur maple, northern white-cedar, laurel willow.	Green ash	Eastern cottonwood, silver maple.
54. Zook	Common ninebark, silky dogwood.	Redosier dogwood, Tatarian honeysuckle, American plum.	Amur maple, northern white-cedar.	Green ash, common hackberry, eastern white pine.	Eastern cottonwood, silver maple.
55. Nicollet	Silky dogwood, gray dogwood.	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, Siberian crabapple, Amur maple.	Eastern white pine, green ash, common hackberry.	Silver maple.
62D2. Storden	Common ninebark	Tatarian honeysuckle, Siberian peashrub, northern white-cedar.	Eastern redcedar, white spruce.	Green ash, Russian-olive, common hackberry.	---
63C, 63E. Chelsea	Lilac, common ninebark.	Siberian peashrub, eastern redcedar, autumn-olive, Russian-olive, Tatarian honeysuckle.	Ponderosa pine, Austrian pine, jack pine, eastern white pine.	---	---
65F, 65G. Lindley	Silky dogwood	Amur honeysuckle, autumn-olive, American plum.	Amur maple, eastern redcedar, Russian-olive.	Eastern white pine, green ash, pin oak.	European alder, silver maple.
88. Nevin	Gray dogwood, silky dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
93D2*, 93E2*:					
Shelby	Silky dogwood, gray dogwood.	Tatarian honeysuckle, lilac, redosier dogwood.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern white pine, silver maple.
Adair	Silky dogwood, gray dogwood.	Lilac, Tatarian honeysuckle, redosier dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern white pine, silver maple.
95. Harps	Gray dogwood, silky dogwood.	Tatarian honeysuckle, redosier dogwood, Zabel honeysuckle, common ninebark.	Laurel willow, northern white-cedar, Amur maple.	Green ash, common hackberry.	Eastern cottonwood.
107. Webster	Redosier dogwood, gray dogwood, silky dogwood.	Zabel honeysuckle, Tatarian honeysuckle, American plum.	Laurel willow, northern white-cedar, Amur maple.	Green ash	Silver maple, eastern cottonwood.
118. Garwin	Silky dogwood, gray dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle, Zabel honeysuckle.	Amur maple, northern white-cedar, laurel willow.	Green ash	Eastern cottonwood, silver maple.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
119. Muscatine	Gray dogwood, silky dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
120, 120B, 120C, 120C2, 120D2, 120E2. Tama	Gray dogwood, silky dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Silver maple, eastern white pine.
122. Sperry	Silky dogwood, gray dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle, Zabel honeysuckle.	Amur maple, northern white-cedar, laurel willow.	Green ash.	Eastern cottonwood, silver maple.
133, 133+, 133B. Colo	Gray dogwood, silky dogwood.	Tatarian honeysuckle, redosier dogwood, Zabel honeysuckle.	Laurel willow, white spruce, Amur maple, northern white-cedar.	Green ash.	Silver maple, eastern cottonwood.
135. Coland	Common ninebark, indiancurrant coralberry.	Redosier dogwood, Tatarian honeysuckle, silky dogwood, Zabel honeysuckle.	White spruce, northern white-cedar, Amur maple.	Green ash.	Eastern cottonwood, silver maple.
138B, 138C, 138C2, 138D2, 138E2. Clarion	Gray dogwood, silky dogwood.	Redosier dogwood, Tatarian honeysuckle, lilac.	Amur maple, eastern redcedar.	Red pine, Norway spruce, common hackberry.	Silver maple, eastern white pine.
150. Hanska	Common ninebark, silky dogwood.	Northern white-cedar, Tatarian honeysuckle, lilac, redosier dogwood.	White spruce, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.
162B, 162C, 162C2, 162D, 162D2, 162E2. Downs	Gray dogwood, silky dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern white pine, silver maple.
163B, 163C, 163D, 163E. Fayette	Gray dogwood, common ninebark.	Redosier dogwood, Tatarian honeysuckle, American plum.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern white pine, silver maple.
163F. Fayette					
175B, 175C, 175D2. Dickinson	Silky dogwood, gray dogwood.	Redosier dogwood, Tatarian honeysuckle, American plum.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Silver maple, eastern white pine.
177, 177C2. Saude	Gray dogwood, silky dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
178. Waukee	Gray dogwood, silky dogwood.	Redosier dogwood, Tatarian honeysuckle, American plum.	Amur maple, eastern redcedar.	Red pine, Norway spruce, common hackberry.	Silver maple, eastern cottonwood.
179E, 179E2, 179F. Gara	Gray dogwood, silky dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern white pine, silver maple.
192D2. Adair	Silky dogwood, gray dogwood.	Lilac, Tatarian honeysuckle, redosier dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern white pine, silver maple.
201B*:					
Coland	Common ninebark, indiancurrant coralberry.	Redosier dogwood, Tatarian honeysuckle, silky dogwood, Zabel honeysuckle.	White spruce, northern white-cedar, Amur maple.	Green ash	Eastern cottonwood, silver maple.
Terril	Gray dogwood, silky dogwood.	Redosier dogwood, Tatarian honeysuckle.	Eastern redcedar, Amur maple, northern white-cedar.	Red pine, Norway spruce, common hackberry.	Silver maple, eastern cottonwood.
220. Nodaway	Common ninebark, silky dogwood.	Redosier dogwood, Tatarian honeysuckle.	Northern white-cedar, Amur maple.	Red pine, green ash, eastern white pine, Norway spruce.	Eastern cottonwood, silver maple.
222D2. Clarinda	Silky dogwood	Redosier dogwood, American plum, Tatarian honeysuckle, Zabel honeysuckle.	Amur maple, northern white-cedar, laurel willow.	Green ash	Eastern cottonwood, silver maple.
226. Lawler	Gray dogwood, silky dogwood.	Redosier dogwood, Tatarian honeysuckle.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Silver maple, eastern cottonwood.
236C, 236C2, 236D2, 236E. Lester	Gray dogwood, silky dogwood.	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, Siberian crabapple, Amur maple, white spruce.	Eastern white pine, green ash, common hackberry, Scotch pine.	Silver maple.
236F. Lester					
323C. Terril	Gray dogwood, silky dogwood.	Redosier dogwood, Tatarian honeysuckle.	Eastern redcedar, Amur maple, northern white-cedar.	Norway spruce, common hackberry, red pine.	Silver maple, eastern cottonwood.
377C, 377C2, 377D2. Dinsdale	Gray dogwood, silky dogwood.	Redosier dogwood, Amur honeysuckle, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern white pine, silver maple.
420B, 420C2. Tama	Gray dogwood, silky dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Silver maple, eastern white pine.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
428B Ely	Gray dogwood, silky dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
430 Ackmore	Silky dogwood, gray dogwood.	Redosier dogwood, Tatarian honeysuckle, lilac.	Amur maple, eastern redcedar.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
442B*, 442C2*, 442E2*:					
Dickinson	Silky dogwood, gray dogwood.	Redosier dogwood, Tatarian honeysuckle, American plum.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Silver maple, eastern white pine.
Sparta	Siberian peashrub	Eastern redcedar, lilac, autumn-olive, Tatarian honeysuckle, Amur honeysuckle.	Austrian pine, Russian-olive.	Eastern white pine, red pine, jack pine, ponderosa pine.	---
Tama	Gray dogwood, silky dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Silver maple, eastern white pine.
462B Downs	Gray dogwood, silky dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern white pine, silver maple.
484 Lawson	Silky dogwood, gray dogwood.	Amur honeysuckle	Eastern redcedar, Russian-olive, northern white-cedar.	Green ash, eastern white pine, Norway spruce, Douglas-fir.	Silver maple, eastern cottonwood.
485 Spillville	Silky dogwood, gray dogwood.	Tatarian honeysuckle, lilac, redosier dogwood.	Amur maple, eastern redcedar.	Norway spruce, common hackberry, red pine.	Eastern cottonwood, silver maple.
507 Canisteo	---	Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Russian-olive, white spruce, northern white-cedar, Siberian crabapple, eastern redcedar.	Green ash, common hackberry, black willow.	---
536 Hanlon	Gray dogwood, silky dogwood.	Redosier dogwood, Tatarian honeysuckle, American plum.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern cottonwood, silver maple.
595 Harpster	Redosier dogwood, Siberian peashrub.	Silky dogwood, Tatarian honeysuckle.	Russian-olive, eastern redcedar, northern white-cedar.	Green ash, common hackberry, white spruce, black willow.	---
683C2, 683D, 683D2, 683E, 683E2 Liscomb	Gray dogwood	Silky dogwood, Tatarian honeysuckle, American plum, redosier dogwood.	Amur maple, eastern redcedar.	Red pine, Norway spruce, common hackberry.	Eastern white pine, silver maple.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
688 Koszta	Gray dogwood, silky dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
1133 Colo	Gray dogwood, silky dogwood.	Tatarian honeysuckle, redosier dogwood, Zabel honeysuckle.	Laurel willow, white spruce, Amur maple, northern white-cedar.	Green ash	Silver maple, eastern cottonwood.
1220 Nodaway	Gray dogwood, silky dogwood.	Tatarian honeysuckle, lilac.	Amur maple, eastern redcedar, northern white-cedar.	Common hackberry, Norway spruce, eastern white pine.	Eastern cottonwood, silver maple.
1485 Spillville	Gray dogwood, silky dogwood.	Redosier dogwood, Tatarian honeysuckle, lilac.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern cottonwood, silver maple.
1936*:					
Colo	Gray dogwood, silky dogwood.	Tatarian honeysuckle, redosier dogwood, Zabel honeysuckle.	Laurel willow, white spruce, Amur maple, northern white-cedar.	Green ash	Silver maple, eastern cottonwood.
Hanlon	Gray dogwood, silky dogwood.	Redosier dogwood, Tatarian honeysuckle, American plum.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern cottonwood, silver maple.
Lawson	Gray dogwood, silky dogwood.	Redosier dogwood, Tatarian honeysuckle.	Amur maple, eastern redcedar, northern white-cedar.	Common hackberry, Norway spruce, eastern white pine.	Eastern cottonwood, silver maple.
4011B*:					
Colo	Gray dogwood, silky dogwood.	Tatarian honeysuckle, redosier dogwood, Zabel honeysuckle.	Laurel willow, white spruce, Amur maple, northern white-cedar.	Green ash	Silver maple, eastern cottonwood.
Ely	Gray dogwood, silky dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
Urban land.					
4119*:					
Muscatine	Gray dogwood, silky dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
Urban land.					
4120B*, 4120C*:					
Tama	Gray dogwood, silky dogwood.	Redosier dogwood, American plum, Tatarian honeysuckle.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Silver maple, eastern white pine.
Urban land.					

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
4133*:					
Colo	Gray dogwood, silky dogwood.	Tatarian honeysuckle, redosier dogwood, Zabel honeysuckle.	Laurel willow, white spruce, Amur maple, northern white-cedar.	Green ash	Silver maple, eastern cottonwood.
Urban land.					
5010*, 5030*. Pits					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
5B*:					
Ackmore	Severe: floods, wetness.	Moderate: wetness, floods.	Severe: wetness, floods.	Moderate: wetness, floods.	Severe: floods.
Colo	Severe: floods, wetness.	Moderate: floods, wetness.	Severe: wetness, floods.	Moderate: floods, wetness.	Severe: floods.
6 Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, erodes easily.	Severe: ponding.
7 Wiota	Severe: floods.	Slight	Moderate: slope.	Slight	Slight.
8B Judson	Slight	Slight	Moderate: slope.	Slight	Slight.
8C Judson	Slight	Slight	Severe: slope.	Slight	Slight.
11B*:					
Colo	Severe: floods, wetness.	Moderate: floods, wetness.	Severe: wetness, floods.	Moderate: floods, wetness.	Severe: floods.
Ely	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight	Slight.
20C2 Killduff	Slight	Slight	Severe: slope.	Slight	Slight.
20D2, 20D3 Killduff	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
20E2, 20E3 Killduff	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
24D2, 24D3 Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
24E2, 24E3, 24F2 Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
41B Sparta	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
41C Sparta	Slight	Slight	Severe: slope.	Slight	Moderate: droughty.
41D Sparta	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
43 Bremer	Severe: wetness, floods.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
51 Vesser	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, floods.
54 Zook	Severe: wetness, floods.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, floods.
55 Nicollet	Slight	Slight	Slight	Slight	Slight.
62D2 Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
63C Chelsea	Slight	Slight	Severe: slope.	Slight	Moderate: droughty.
63E Chelsea	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope, droughty.
65F Lindley	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
65G Lindley	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
88 Nevin	Severe: floods.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
93D2*:					
Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
Adair	Severe: wetness.	Moderate: wetness, slope, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: slope, wetness.
93E2*:					
Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Adair	Severe: slope, wetness.	Severe: slope.	Severe: slope, wetness.	Moderate: wetness, slope.	Severe: slope.
95 Harps	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
107 Webster	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
118 Garwin	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
119 Muscatine	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
120 Tama	Slight	Slight	Slight	Slight	Slight.
120B Tama	Slight	Slight	Moderate: slope.	Slight	Slight.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
120C, 120C2 Tama	Slight	Slight	Severe: slope.	Slight	Slight.
120D2 Tama	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
120E2 Tama	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
122 Sperry	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
133 Colo	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, floods.
133+ Colo	Severe: floods, wetness.	Moderate: floods, wetness.	Severe: wetness, floods.	Moderate: floods, wetness.	Severe: floods.
133B Colo	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, floods.
135 Coland	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, floods.
138B Clarion	Slight	Slight	Moderate: slope.	Slight	Slight.
138C, 138C2 Clarion	Slight	Slight	Severe: slope.	Slight	Slight.
138D2 Clarion	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
138E2 Clarion	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
150 Hanska	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
162B Downs	Slight	Slight	Moderate: slope.	Slight	Slight.
162C, 162C2 Downs	Slight	Slight	Severe: slope.	Slight	Slight.
162D, 162D2 Downs	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
162E2 Downs	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
163B Fayette	Slight	Slight	Moderate: slope.	Slight	Slight.
163C Fayette	Slight	Slight	Severe: slope.	Slight	Slight.
163D Fayette	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
163E, 163F: Fayette	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
175B: Dickinson	Slight	Slight	Moderate: slope.	Slight	Slight.
175C: Dickinson	Slight	Slight	Severe: slope.	Slight	Slight.
175D2: Dickinson	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
177: Saude	Slight	Slight	Slight	Slight	Slight.
177C2: Saude	Slight	Slight	Severe: slope.	Slight	Slight.
178: Waukee	Slight	Slight	Slight	Slight	Slight.
179E, 179E2, 179F: Gara	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
192D2: Adair	Severe: wetness.	Moderate: wetness, slope, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: slope, wetness.
201B*:					
Coland	Severe: floods, wetness.	Moderate: floods, wetness.	Severe: wetness, floods.	Moderate: wetness, floods.	Severe: floods.
Terril	Slight	Slight	Slight	Slight	Slight.
220: Nodaway	Severe: floods.	Slight	Moderate: floods.	Slight	Moderate: floods.
222D2: Clarinda	Severe: percs slowly, wetness.	Severe: percs slowly.	Severe: slope, wetness, percs slowly.	Severe: erodes easily.	Moderate: wetness, slope.
226: Lawler	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
236C, 236C2: Lester	Slight	Slight	Severe: slope.	Slight	Slight.
236D2: Lester	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
236E, 236F: Lester	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
323C: Terril	Slight	Slight	Severe: slope.	Slight	Slight.
377C, 377C2: Dinsdale	Slight	Slight	Severe: slope.	Slight	Slight.
377D2: Dinsdale	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
420B Tama	Slight	Slight	Moderate: slope.	Slight	Slight.
420C2 Tama	Slight	Slight	Severe: slope.	Slight	Slight.
428B Ely	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight	Slight.
430 Ackmore	Severe: floods, wetness.	Moderate: wetness, floods.	Severe: wetness, floods.	Moderate: wetness, floods.	Severe: floods.
442B*:					
Dickinson	Slight	Slight	Moderate: slope.	Slight	Slight.
Sparta	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
Tama	Slight	Slight	Moderate: slope.	Slight	Slight.
442C2*:					
Dickinson	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Sparta	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
Tama	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
442E2*:					
Dickinson	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Sparta	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Tama	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
462B Downs	Slight	Slight	Moderate: slope.	Slight	Slight.
484 Lawson	Severe: floods, wetness.	Moderate: wetness, floods.	Severe: wetness, floods.	Moderate: wetness floods.	Severe: floods.
485 Spillville	Severe: floods.	Slight	Moderate: floods.	Slight	Moderate: floods.
507 Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
536 Hanlon	Severe: floods.	Slight	Moderate: floods.	Slight	Moderate: floods.
595 Harpster	Severe: floods, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
683C2 Liscomb	Slight	Slight	Severe: slope.	Slight	Slight.
683D, 683D2 Liscomb	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
683E, 683E2 Liscomb	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
688 Koszta	Severe: floods.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
1133 Colo	Severe: floods, wetness.	Moderate: floods, wetness.	Severe: wetness, floods.	Moderate: floods, wetness.	Severe: floods.
1220 Nodaway	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.	Severe: floods.
1485 Spillville	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.	Severe: floods.
1936*:					
Colo	Severe: floods, wetness.	Moderate: floods, wetness.	Severe: wetness, floods.	Moderate: floods, wetness.	Severe: floods.
Hanlon	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.	Severe: floods.
Lawson	Severe: floods, wetness.	Moderate: floods, wetness.	Severe: wetness, floods.	Moderate: wetness, floods.	Severe: floods.
4011B*:					
Colo	Severe: floods, wetness.	Moderate: floods, wetness.	Severe: wetness, floods.	Moderate: floods, wetness.	Severe: floods.
Ely	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight	Slight.
Urban land.					
4119*:					
Muscatine	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
Urban land.					
4120B*:					
Tama	Slight	Slight	Moderate: slope.	Slight	Slight.
Urban land.					
4120C*:					
Tama	Slight	Slight	Severe: slope.	Slight	Slight.
Urban land.					

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
4133*:					
Colo	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, floods.
Urban land.					
5010*, 5030*. Pits					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
5B*:										
Ackmore	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Colo	Good	Fair	Good	Fair	Poor	Fair	Very poor.	Fair	Fair	Poor.
6 Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
7 Wiota	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
8B Judson	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
8C Judson	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
11B*:										
Colo	Good	Fair	Good	Fair	Poor	Fair	Very poor.	Fair	Fair	Poor.
Ely	Good	Good	Good	Good	Good	Fair	Very poor.	Good	Good	Poor.
20C2 Killduff	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
20D2, 20D3 Killduff	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
20E2, 20E3 Killduff	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
24D2, 24D3 Shelby	Fair	Good	Fair	Good	Good	Poor	Poor	Fair	Good	Poor.
24E2, 24E3, 24F2 Shelby	Poor	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Poor.
41B Sparta	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
41C, 41D Sparta	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
43 Bremer	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
51 Vesser	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
54 Zook	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
55 Nicollet	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
62D2 Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
63C. Chelsea	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
63E. Chelsea	Very poor.	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
65F. Lindley	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
65G. Lindley	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
88. Nevin	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
93D2*:										
Shelby	Fair	Good	Fair	Good	Good	Poor	Poor	Fair	Good	Poor.
Adair	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
93E2*:										
Shelby	Poor	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Poor.
Adair	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
95. Harps	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
107. Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
118. Garwin	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
119. Muscatine	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
120, 120B. Tama	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
120C, 120C2, 120D2, 120E2. Tama	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
122. Sperry	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
133, 133+. Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
133B. Colo	Good	Fair	Good	Fair	Poor	Fair	Very poor.	Fair	Fair	Poor.
135. Coland	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
138B. Clarion	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
138C, 138C2, 138D2. Clarion	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
138E2. Clarion	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
150----------------- Hanska	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
162B---------------- Downs	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
162C, 162C2, 162D, 162D2------------- Downs	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
162E2--------------- Downs	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
163B---------------- Fayette	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
163C, 163D---------- Fayette	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
163E, 163F---------- Fayette	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
175B---------------- Dickinson	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
175C, 175D2--------- Dickinson	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
177----------------- Saude	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
177C2--------------- Saude	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
178----------------- Waukee	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
179E, 179E2, 179F-- Gara	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
192D2--------------- Adair	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
201B*:										
Coland-------------	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
Terril-------------	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
220----------------- Nodaway	Good	Good	Good	Good	Fair	Fair	Poor	Fair	Good	Fair.
222D2--------------- Clarinda	Poor	Fair	Poor	Fair	Poor	Poor	Poor	Fair	Fair	Poor.
226----------------- Lawler	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
236C, 236C2, 236D2, 236E--------------- Lester	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
236F---------------- Lester	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
323C---------------- Terril	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba-ceous plants	Hardwood trees	Conif-erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
377C, 377C2, 377D2- Dinsdale	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
420B---------------- Tama	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
420C2--------------- Tama	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
428B---------------- Ely	Good	Good	Good	Good	Good	Fair	Very poor.	Good	Good	Poor.
430----------------- Ackmore	Very poor.	Poor	Good	Good	Good	Fair	Fair	Poor	Good	Fair.
442B*:										
Dickinson----------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Sparta-------------	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Tama---------------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
442C2*:										
Dickinson----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Sparta-------------	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Tama---------------	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
442E2*:										
Dickinson----------	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Fair	Very poor.
Sparta-------------	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Tama---------------	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
462B---------------- Downs	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
484----------------- Lawson	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
485----------------- Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
507----------------- Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
536----------------- Hanlon	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
595----------------- Harpster	Fair	Fair	Good	Fair	Fair	Good	Fair	Fair	Fair	Fair.
683C2--------------- Liscomb	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba- ceous plants	Hardwood trees	Conif- erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
683D, 683D2 Liscomb	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
683E, 683E2 Liscomb	Fair	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
688 Koszta	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
1133 Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
1220 Nodaway	Poor	Fair	Fair	Poor	Poor	Good	Fair	Poor	Poor	Fair.
1485 Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
1936*:										
Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
Hanlon	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
Lawson	Poor	Fair	Fair	Poor	Poor	Good	Fair	Poor	Poor	Fair.
4011B*:										
Colo	Good	Fair	Good	Fair	Poor	Fair	Very poor.	Fair	Fair	Poor.
Ely	Good	Good	Good	Good	Good	Fair	Very poor.	Good	Good	Poor.
Urban land.										
4119*:										
Muscatine	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Urban land.										
4120B*:										
Tama	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Urban land.										
4120C*:										
Tama	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Urban land.										
4133*:										
Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
Urban land.										
5010*, 5030*. Pits										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
5B*:						
Ackmore	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness.	Severe: low strength, floods, frost action.	Severe: floods.
Colo	Severe: wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, low strength, frost action.	Severe: floods.
6 Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
7 Wiota	Slight	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength, frost action.	Slight.
8B Judson	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
8C Judson	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
11B*:						
Colo	Severe: wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, low strength, frost action.	Severe: floods.
Ely	Severe: wetness.	Severe: low strength.	Severe: low strength, wetness.	Severe: low strength.	Severe: frost action, low strength.	Slight.
20C2 Killduff	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
20D2, 20D3 Killduff	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
20E2, 20E3 Killduff	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope, frost action.	Severe: slope.
24D2, 24D3 Shelby	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
24E2, 24E3, 24F2 Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
41B Sparta	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
41C Sparta	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
41D---------------- Sparta	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
43---------------- Bremer	Severe: wetness.	Severe: wetness, shrink-swell, floods.	Severe: wetness, shrink-swell, floods.	Severe: wetness, shrink-swell, floods.	Severe: low strength, frost action.	Moderate: wetness.
51---------------- Vesser	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, low strength, frost action.	Moderate: wetness, floods.
54---------------- Zook	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, low strength, frost action.	Moderate: wetness, floods.
55---------------- Nicollet	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
62D2-------------- Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
63C--------------- Chelsea	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
63E--------------- Chelsea	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope, droughty.
65F, 65G---------- Lindley	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
88---------------- Nevin	Severe: wetness.	Severe: floods.	Severe: wetness, floods.	Severe: floods.	Severe: frost action, low strength.	Slight.
93D2*:						
Shelby-----------	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
Adair------------	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: wetness.	Severe: shrink-swell, wetness, slope.	Severe: low strength, frost action.	Moderate: slope, wetness.
93E2*:						
Shelby-----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
Adair------------	Severe: wetness, slope.	Severe: shrink-swell, wetness, slope.	Severe: wetness, slope.	Severe: shrink-swell, wetness, slope.	Severe: low strength, slope, frost action.	Severe: slope.
95---------------- Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
107--------------- Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
118 Garwin	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: frost action, low strength, shrink-swell.	Moderate: wetness.
119 Muscatine	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.	Slight.
120, 120B Tama	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: frost action, low strength.	Slight.
120C, 120C2 Tama	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Severe: frost action, low strength.	Slight.
120D2 Tama	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: frost action, low strength.	Moderate: slope.
120E2 Tama	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, frost action, low strength.	Severe: slope.
122 Sperry	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
133 Colo	Severe: wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, low strength, frost action.	Moderate: wetness, floods.
133+ Colo	Severe: wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, low strength, frost action.	Severe: floods.
133B Colo	Severe: wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, low strength, frost action.	Moderate: wetness, floods.
135 Coland	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, low strength, frost action.	Moderate: wetness, floods.
138B Clarion	Slight	Slight	Slight	Slight	Moderate: frost action.	Slight.
138C, 138C2 Clarion	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
138D2 Clarion	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
138E2 Clarion	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
150 Hanska	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
162B Downs	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: frost action, low strength.	Slight.
162C, 162C2 Downs	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Severe: frost action, low strength.	Slight.
162D, 162D2 Downs	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: frost action, low strength.	Moderate: slope.
162E2 Downs	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, frost action, low strength.	Severe: slope.
163B Fayette	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: frost action, low strength.	Slight.
163C Fayette	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Severe: frost action, low strength.	Slight.
163D Fayette	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: frost action, low strength.	Moderate: slope.
163E, 163F Fayette	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: frost action, low strength, slope.	Severe: slope.
175B Dickinson	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: frost action.	Slight.
175C Dickinson	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
175D2 Dickinson	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
177 Saude	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.
177C2 Saude	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Slight.
178 Waukee	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: low strength.	Slight.
179E, 179E2, 179F Gara	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
192D2 Adair	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: wetness.	Severe: shrink-swell, wetness, slope.	Severe: low strength, frost action.	Moderate: slope, wetness.
201B*: Coland	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, low strength, frost action.	Severe: floods.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
201B*:						
Terril	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: low strength, frost action.	Slight.
220 Nodaway	Moderate: wetness, floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, frost action, low strength.	Moderate: floods.
222D2 Clarinda	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell, slope.	Severe: frost action, low strength, shrink-swell.	Moderate: wetness, slope.
226 Lawler	Severe: wetness, cutbanks cave.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
236C, 236C2 Lester	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
236D2 Lester	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
236E, 236F Lester	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
323C Terril	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.
377C, 377C2 Dinsdale	Slight	Moderate: shrink-swell.	Slight	Moderate: slope, shrink-swell.	Severe: frost action, low strength.	Slight.
377D2 Dinsdale	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope.	Severe: slope.	Severe: frost action, low strength.	Moderate: slope.
420B Tama	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: frost action, low strength.	Slight.
420C2 Tama	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Severe: frost action, low strength.	Slight.
428B Ely	Severe: wetness.	Severe: low strength.	Severe: low strength, wetness.	Severe: low strength.	Severe: frost action, low strength.	Slight.
430 Ackmore	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness.	Severe: low strength, floods, frost action.	Severe: floods.
442B*:						
Dickinson	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: frost action.	Slight.
Sparta	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
Tama	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: frost action, low strength.	Slight.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
442C2*:						
Dickinson	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Sparta	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
Tama	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: frost action, low strength.	Moderate: slope.
442E2*:						
Dickinson	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Sparta	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Tama	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, frost action, low strength.	Severe: slope.
462B Downs	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: frost action, low strength.	Slight.
484 Lawson	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, frost action.	Severe: floods.
485 Spillville	Moderate: floods, wetness.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength, floods.	Moderate: floods.
507 Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
536 Hanlon	Severe: cutbanks cave.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods.
595 Harpster	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: low strength, wetness, floods.	Severe: wetness.
683C2 Liscomb	Slight	Slight	Slight	Moderate: slope.	Severe: low strength.	Slight.
683D, 683D2 Liscomb	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength.	Moderate: slope.
683E, 683E2 Liscomb	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, low strength.	Severe: slope.
688 Koszta	Severe: wetness.	Severe: floods.	Severe: floods, wetness.	Severe: floods.	Severe: low strength, frost action.	Slight.
1133 Colo	Severe: wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, low strength, frost action.	Severe: floods.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1220------------- Nodaway	Moderate: wetness, floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, frost action, low strength.	Severe: floods.
1485------------- Spillville	Moderate: floods, wetness.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength, floods.	Severe: floods.
1936*:						
Colo-------------	Severe: wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, low strength, frost action.	Severe: floods.
Hanlon-----------	Severe: cutbanks cave.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
Lawson-----------	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, frost action.	Severe: floods.
4011B*:						
Colo-------------	Severe: wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, low strength, frost action.	Severe: floods.
Ely--------------	Severe: wetness.	Severe: low strength.	Severe: low strength, wetness.	Severe: low strength.	Severe: frost action, low strength.	Slight.
Urban land.						
4119*:						
Muscatine--------	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.	Slight.
Urban land.						
4120B*:						
Tama-------------	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: frost action, low strength.	Slight.
Urban land.						
4120C*:						
Tama-------------	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Severe: frost action, low strength.	Slight.
Urban land.						
4133*:						
Colo-------------	Severe: wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, low strength, frost action.	Moderate: wetness, floods.
Urban land.						
5010*, 5030*. Pits						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
5B*:					
Ackmore	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness, hard to pack.
Colo	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness, hard to pack.
6 Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: hard to pack, ponding.
7 Wiota	Moderate: floods, percs slowly.	Severe: floods.	Moderate: floods, too clayey.	Moderate: floods.	Fair: too clayey.
8B Judson	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
8C Judson	Slight	Severe: slope.	Slight	Slight	Good.
11B*:					
Colo	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness, hard to pack.
Ely	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
20C2 Killduff	Slight	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
20D2, 20D3 Killduff	Moderate: slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
20E2, 20E3 Killduff	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
24D2, 24D3 Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
24E2, 24E3, 24F2 Shelby	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
41B Sparta	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
41C, 41D Sparta	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
43 Bremer	Severe: percs slowly, wetness.	Severe: wetness, floods.	Severe: wetness.	Severe: wetness.	Poor: wetness.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
51 Vesser	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
54 Zook	Severe: percs slowly, wetness, floods.	Severe: wetness, floods.	Severe: wetness, too clayey, floods.	Severe: wetness, floods.	Poor: too clayey, wetness, hard to pack.
55 Nicollet	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
62D2 Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
63C, 63E Chelsea	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
65F, 65G Lindley	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
88 Nevin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
93D2*:					
Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
Adair	Severe: percs slowly, wetness.	Severe: slope, wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
93E2*:					
Shelby	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Adair	Severe: percs slowly, slope, wetness.	Severe: slope, wetness.	Severe: wetness, slope.	Severe: wetness, slope.	Poor: slope, wetness.
95 Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
107 Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
118 Garwin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
119 Muscatine	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
120 Tama	Slight	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
120B Tama	Slight	Moderate: slope, seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
120C, 120C2 Tama	Slight	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
120D2: Tama	Moderate: slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: slope, too clayey.
120E2: Tama	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
122: Sperry	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
133, 133+, 133B: Colo	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness, hard to pack.
135: Coland	Severe: floods, wetness.	Severe: floods, wetness, seepage.	Severe: floods, wetness, seepage.	Severe: floods, wetness.	Poor: wetness, hard to pack.
138B: Clarion	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
138C, 138C2: Clarion	Slight	Severe: slope.	Slight	Slight	Good.
138D2: Clarion	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
138E2: Clarion	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
150: Hanska	Severe: wetness, poor filter.	Severe: wetness, seepage.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
162B: Downs	Slight	Moderate: slope, seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
162C, 162C2: Downs	Slight	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
162D, 162D2: Downs	Moderate: slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: slope, too clayey.
162E2: Downs	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
163B: Fayette	Slight	Moderate: slope, seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
163C: Fayette	Slight	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
163D: Fayette	Moderate: slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: slope, too clayey.
163E, 163F: Fayette	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
175B----------------- Dickinson	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
175C, 175D2---------- Dickinson	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
177------------------ Saude	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage, small stones.
177C2---------------- Saude	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage, small stones.
178------------------ Waukee	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: too sandy, seepage.
179E, 179E2, 179F---- Gara	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
192D2---------------- Adair	Severe: percs slowly, wetness.	Severe: slope, wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
201B*:					
Coland--------------	Severe: floods, wetness.	Severe: floods, wetness, seepage.	Severe: floods, wetness, seepage.	Severe: floods, wetness.	Poor: wetness, hard to pack.
Terril--------------	Slight------------	Severe: seepage.	Severe: seepage.	Slight------------	Good.
220------------------ Nodaway	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Fair: wetness.
222D2---------------- Clarinda	Severe: wetness, percs slowly.	Severe: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, wetness, hard to pack.
226------------------ Lawler	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
236C, 236C2---------- Lester	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight------------	Fair: too clayey.
236D2---------------- Lester	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
236E, 236F----------- Lester	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
323C----------------- Terril	Slight------------	Severe: seepage, slope.	Severe: seepage.	Slight------------	Good.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
377C, 377C2 Dinsdale	Slight	Severe: slope.	Slight	Slight	Good.
377D2 Dinsdale	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
420B Tama	Slight	Moderate: slope, seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
420C2 Tama	Slight	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
428B Ely	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
430 Ackmore	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness, hard to pack.
442B*:					
Dickinson	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Sparta	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Tama	Slight	Moderate: slope, seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
442C2*:					
Dickinson	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Sparta	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Tama	Moderate: slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: slope, too clayey.
442E2*:					
Dickinson	Severe: slope, poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy, slope.	Severe: seepage, slope.	Poor: slope, seepage, too sandy.
Sparta	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
Tama	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
462B Downs	Slight	Moderate: sslope, seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
484 Lawson	Severe: floods, wetness.	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
485----------------- Spillville	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Severe: wetness, floods.	Fair: wetness.
507----------------- Canisteo	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
536----------------- Hanlon	Severe: floods, wetness.	Severe: seepage, floods, wetness.	Severe: floods, seepage, wetness.	Severe: floods, seepage, wetness.	Fair: wetness.
595----------------- Harpster	Severe: floods, wetness.	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: hard to pack, wetness.
683C2--------------- Liscomb	Moderate: percs slowly.	Severe: slope.	Slight-----------	Slight-----------	Good.
683D, 683D2--------- Liscomb	Moderate: slope, percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
683E, 683E2--------- Liscomb	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
688----------------- Koszta	Severe: wetness.	Severe: floods, wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
1133---------------- Colo	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness, hard to pack.
1220---------------- Nodaway	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Fair: wetness.
1485---------------- Spillville	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Severe: wetness, floods.	Fair: wetness.
1936*:					
Colo----------------	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness, hard to pack.
Hanlon--------------	Severe: floods, wetness.	Severe: seepage, floods, wetness.	Severe: floods, seepage, wetness.	Severe: floods, seepage, wetness.	Fair: wetness.
Lawson--------------	Severe: floods, wetness.	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
4011B*:					
Colo----------------	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness, hard to pack.
Ely-----------------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
Urban land.					

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
4119*:					
Muscatine	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
Urban land.					
4120B*:					
Tama	Slight	Moderate: slope, seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
Urban land.					
4120C*:					
Tama	Slight	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Urban land.					
4133*:					
Colo	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness, hard to pack.
Urban land.					
5010*, 5030*. Pits					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
5B*:				
Ackmore	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
6 Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
7 Wiota	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
8B, 8C Judson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
11B*:				
Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ely	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
20C2 Killduff	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
20D2, 20D3 Killduff	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
20E2, 20E3 Killduff	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
24D2 Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer, slope.
24D3 Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
24E2, 24E3, 24F2 Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Severe: slope.
41B, 41C Sparta	Good	Probable	Improbable: too sandy.	Fair: too sandy.
41D Sparta	Good	Probable	Improbable: too sandy.	Fair: slope, too sandy.
43 Bremer	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
51 Vesser	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
54: Zook	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
55: Nicollet	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
62D2: Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
63C: Chelsea	Good	Probable	Improbable: too sandy.	Fair: too sandy.
63E: Chelsea	Good	Probable	Improbable: too sandy.	Fair: too sandy, slope.
65F: Lindley	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
65G: Lindley	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
88: Nevin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
93D2*:				
Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer, slope.
Adair	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
93E2*:				
Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Severe: slope.
Adair	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, slope.
95: Harps	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
107: Webster	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
118: Garwin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
119: Muscatine	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
120, 120B, 120C, 120C2: Tama	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
120D2: Tama	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
120E2 Tama	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
122 Sperry	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
133, 133+, 133B Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
135 Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
138B, 138C, 138C2 Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
138D2 Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
138E2 Clarion	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
150 Hanska	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
162B, 162C, 162C2 Downs	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
162D, 162D2 Downs	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
162E2 Downs	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
163B, 163C Fayette	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
163D Fayette	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, thin layer.
163E, 163F Fayette	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
175B, 175C Dickinson	Good	Probable	Improbable: too sandy.	Good.
175D2 Dickinson	Good	Probable	Improbable: too sandy.	Fair: slope.
177, 177C2 Saude	Good	Probable	Probable	Good.
178 Waukee	Good	Probable	Improbable: too sandy.	Good.
179E, 179E2, 179F Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
192D2 Adair	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
201B*: Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
201B*:				
Terril	Good	Probable	Improbable: too sandy.	Good.
220 Nodaway	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
222D2 Clarinda	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, thin layer, slope.
226 Lawler	Fair: wetness.	Probable	Probable	Poor: area reclaim.
236C, 236C2 Lester	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
236D2 Lester	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
236E, 236F Lester	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
323C Terril	Good	Probable	Improbable: too sandy.	Good.
377C, 377C2 Dinsdale	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
377D2 Dinsdale	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
420B, 420C2 Tama	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
428B Ely	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
430 Ackmore	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
442B*:				
Dickinson	Good	Probable	Improbable: too sandy.	Good.
Sparta	Good	Probable	Improbable: too sandy.	Fair: too sandy.
Tama	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
442C2*:				
Dickinson	Good	Probable	Improbable: too sandy.	Fair: slope.
Sparta	Good	Probable	Improbable: too sandy.	Fair: slope, too sandy.
Tama	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
442E2*:				
Dickinson	Fair: slope.	Probable	Improbable: too sandy.	Poor: slope.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
442E2*:				
Sparta	Fair: slope.	Probable	Improbable: too sandy.	Poor: slope.
Tama	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
462B Downs	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
484 Lawson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
485 Spillville	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
507 Canisteo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
536 Hanlon	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
595 Harpster	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
683C2 Liscomb	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
683D, 683D2 Liscomb	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
683E, 683E2 Liscomb	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
688 Koszta	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
1133 Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
1220 Nodaway	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
1485 Spillville	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
1936*:				
Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Hanlon	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Lawson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
4011B*:				
Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ely	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Urban land.				

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
4119*:				
Muscatine	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Urban land.				
4120B*, 4120C*:				
Tama	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Urban land.				
4133*:				
Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Urban land.				
5010*, 5030*. Pits				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
5B*:						
Ackmore	Moderate: seepage, slope.	Severe: hard to pack, wetness.	Floods, slope, frost action.	Wetness, erodes easily, slope.	Wetness, erodes easily.	Wetness, erodes easily.
Colo	Moderate: seepage, slope.	Severe: wetness.	Floods, frost action, slope.	Wetness, slope, floods.	Wetness	Wetness.
6 Okoboji	Moderate: seepage.	Severe: ponding.	Ponding, frost action.	Ponding, erodes easily.	Erodes easily, ponding.	Wetness, erodes easily.
7 Wiota	Moderate: seepage.	Slight	Deep to water	Favorable	Erodes easily	Erodes easily.
8B, 8C Judson	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
11B*:						
Colo	Moderate: seepage, slope.	Severe: wetness.	Floods, frost action, slope.	Wetness, slope, floods.	Wetness	Wetness.
Ely	Moderate: slope, seepage.	Moderate: wetness.	Slope, frost action.	Slope, wetness.	Erodes easily, wetness.	Erodes easily.
20C2 Killduff	Moderate: seepage, slope.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
20D2, 20D3, 20E2, 20E3 Killduff	Severe: slope.	Slight	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
24D2, 24D3, 24E2, 24E3, 24F2 Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
41B, 41C Sparta	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
41D Sparta	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
43 Bremer	Slight	Severe: wetness, hard to pack.	Frost action	Wetness	Wetness	Wetness.
51 Vesser	Moderate: seepage.	Severe: wetness.	Floods, frost action.	Floods, wetness.	Wetness, erodes easily.	Erodes easily, wetness.
54 Zook	Slight	Severe: hard to pack, wetness.	Floods, percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
55 Nicollet	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Wetness	Favorable.
62D2 Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
63C. Chelsea	Severe: seepage.	Severe: piping, seepage.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
63E. Chelsea	Severe: slope, seepage.	Severe: piping, seepage.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
65F, 65G. Lindley	Severe: slope.	Slight	Deep to water	Rooting depth, slope.	Slope	Slope, rooting depth.
88. Nevin	Moderate: seepage.	Moderate: wetness.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
93D2*, 93E2*:						
Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
Adair	Severe: slope.	Moderate: wetness.	Percs slowly, slope, frost action.	Wetness, percs slowly, slope.	Slope, wetness.	Wetness, slope.
95. Harps	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
107. Webster	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
118. Garwin	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
119. Muscatine	Moderate: seepage.	Moderate: wetness.	Frost action	Wetness	Wetness, erodes easily.	Erodes easily.
120. Tama	Moderate: seepage.	Slight	Deep to water	Favorable	Erodes easily	Erodes easily.
120B, 120C, 120C2. Tama	Moderate: slope, seepage.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
120D2, 120E2. Tama	Severe: slope.	Slight	Deep to water	Slope	Erodes easily, slope.	Slope, erodes easily.
122. Sperry	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding.	Wetness, erodes easily, percs slowly.
133, 133+. Colo	Moderate: seepage.	Severe: wetness.	Floods, frost action.	Floods, wetness.	Wetness	Wetness.
133B. Colo	Moderate: seepage, slope.	Severe: wetness.	Floods, frost action, slope.	Wetness, slope, floods.	Wetness	Wetness.
135. Coland	Moderate: seepage.	Severe: wetness.	Floods, frost action.	Wetness, floods.	Wetness	Wetness.
138B, 138C, 138C2. Clarion	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
138D2, 138E2. Clarion	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
150. Hanska	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
162B, 162C, 162C2-Downs	Moderate: slope, seepage.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
162D, 162D2, 162E2-Downs	Severe: slope.	Slight	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
163B, 163C-Fayette	Moderate: slope, seepage.	Slight	Deep to water	Slope, erodes easily.	Favorable	Erodes easily.
163D, 163E, 163F-Fayette	Severe: slope.	Slight	Deep to water	Slope, erodes easily.	Slope	Slope, erodes easily.
175B, 175C-Dickinson	Severe: seepage.	Severe: seepage.	Deep to water	Soil blowing, slope.	Soil blowing, too sandy.	Favorable.
175D2-Dickinson	Severe: slope, seepage.	Severe: seepage.	Deep to water	Soil blowing, slope.	Soil blowing, too sandy, slope.	Slope.
177-Saude	Severe: seepage.	Severe: seepage.	Deep to water	Favorable	Too sandy	Favorable.
177C2-Saude	Severe: seepage.	Severe: seepage.	Deep to water	Slope	Too sandy	Favorable.
178-Waukee	Severe: seepage.	Severe: seepage.	Deep to water	Favorable	Too sandy	Favorable.
179E, 179E2, 179F-Gara	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
192D2-Adair	Severe: slope.	Moderate: wetness.	Percs slowly, slope, frost action.	Wetness, percs slowly, slope.	Slope, wetness.	Wetness, slope.
201B*:						
Coland	Moderate: seepage.	Severe: wetness.	Floods, frost action.	Wetness, floods.	Wetness	Wetness.
Terril	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Favorable	Favorable	Favorable.
220-Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Floods, erodes easily.	Erodes easily	Erodes easily.
222D2-Clarinda	Severe: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Slope, wetness, erodes easily.	Wetness, slope, erodes easily.
226-Lawler	Severe: seepage.	Severe: seepage.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Favorable.
236C, 236C2-Lester	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Slope	Erodes easily	Erodes easily.
236D2, 236E, 236F-Lester	Severe: slope.	Severe: thin layer.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
323C-Terril	Moderate: seepage, slope.	Moderate: thin layer, piping.	Deep to water	Slope	Favorable	Favorable.
377C, 377C2-Dinsdale	Moderate: slope, seepage.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
377D2------------- Dinsdale	Severe: slope.	Slight----------	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
420B, 420C2------- Tama	Moderate: slope, seepage.	Slight----------	Deep to water	Slope----------	Erodes easily	Erodes easily.
428B-------------- Ely	Moderate: slope, seepage.	Moderate: wetness.	Slope, frost action.	Slope, wetness.	Erodes easily, wetness.	Erodes easily.
430--------------- Ackmore	Moderate: seepage.	Severe: hard to pack, wetness.	Floods, frost action.	Wetness, erodes easily.	Wetness, erodes easily.	Wetness, erodes easily.
442B*:						
Dickinson---------	Severe: seepage.	Severe: seepage.	Deep to water	Soil blowing, slope.	Soil blowing, too sandy.	Favorable.
Sparta------------	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Tama--------------	Moderate: slope, seepage.	Slight----------	Deep to water	Slope----------	Erodes easily	Erodes easily.
442C2*, 442E2*:						
Dickinson---------	Severe: slope, seepage.	Severe: seepage.	Deep to water	Soil blowing, slope.	Soil blowing, too sandy, slope.	Slope.
Sparta------------	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
Tama--------------	Severe: slope.	Slight----------	Deep to water	Slope----------	Erodes easily, slope.	Slope, erodes easily.
462B-------------- Downs	Moderate: slope, seepage.	Slight----------	Deep to water	Slope----------	Erodes easily	Erodes easily.
484--------------- Lawson	Moderate: seepage.	Severe: wetness.	Floods, frost action.	Wetness, floods.	Erodes easily, wetness.	Wetness, erodes easily.
485--------------- Spillville	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Floods----------	Favorable-------	Favorable.
507--------------- Canisteo	Severe: seepage.	Severe: wetness.	Frost action---	Wetness---------	Wetness---------	Wetness.
536--------------- Hanlon	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, floods.	Soil blowing---	Favorable.
595--------------- Harpster	Moderate: seepage.	Severe: wetness.	Floods, frost action.	Wetness, floods.	Wetness---------	Wetness.
683C2------------- Liscomb	Moderate: slope.	Slight----------	Deep to water	Slope----------	Favorable-------	Favorable.
683D, 683D2, 683E, 683E2------------ Liscomb	Severe: slope.	Slight----------	Deep to water	Slope----------	Slope----------	Slope.
688--------------- Koszta	Moderate: seepage.	Moderate: wetness.	Frost action---	Wetness---------	Erodes easily, wetness.	Erodes easily.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
1133-------------- Colo	Moderate: seepage.	Severe: wetness.	Floods, frost action.	Floods, wetness.	Wetness---------	Wetness.
1220-------------- Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Floods, erodes easily.	Erodes easily	Erodes easily.
1485-------------- Spillville	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Floods----------	Favorable-------	Favorable.
1936*:						
Colo--------------	Moderate: seepage.	Severe: wetness.	Floods, frost action.	Floods, wetness.	Wetness---------	Wetness.
Hanlon------------	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, floods.	Soil blowing----	Favorable.
Lawson------------	Moderate: seepage.	Severe: wetness.	Floods, frost action.	Wetness, floods.	Erodes easily, wetness.	Wetness, erodes easily.
4011B*:						
Colo--------------	Moderate: seepage, slope.	Severe: wetness.	Floods, frost action, slope.	Wetness, slope, floods.	Wetness---------	Wetness.
Ely---------------	Moderate: slope, seepage.	Moderate: wetness.	Slope, frost action.	Slope, wetness.	Erodes easily, wetness.	Erodes easily.
Urban land.						
4119*:						
Muscatine---------	Moderate: seepage.	Moderate: wetness.	Frost action---	Wetness---------	Wetness, erodes easily.	Erodes easily.
Urban land.						
4120B*, 4120C*:						
Tama--------------	Moderate: slope, seepage.	Slight----------	Deep to water	Slope-----------	Erodes easily	Erodes easily.
Urban land.						
4133*:						
Colo--------------	Moderate: seepage.	Severe: wetness.	Floods, frost action.	Floods, wetness.	Wetness---------	Wetness.
Urban land.						
5010*, 5030*. Pits						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
5B*:											
Ackmore----------	0-27	Silt loam--------	CL, ML	A-4, A-6, A-7	0	100	100	95-100	85-100	25-50	8-20
	27-60	Silty clay loam, silt loam.	CH, CL, MH, ML	A-7, A-6	0	100	100	95-100	85-100	35-60	15-30
Colo------------	0-11	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	11-60	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
6---------------- Okoboji	0-28	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	28-60	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
7---------------- Wiota	0-26	Silty clay loam	CL	A-6	0	100	100	100	90-95	30-40	10-20
	26-49	Silty clay loam	CL	A-7	0	100	100	95-100	90-95	40-50	15-25
	49-60	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	90-95	40-50	20-30
8B, 8C----------- Judson	0-34	Silty clay loam	CL, CL-ML	A-6, A-7, A-4	0	100	100	100	95-100	25-50	5-25
	34-60	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	30-50	15-25
11B*:											
Colo------------	0-11	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	11-60	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
Ely-------------	0-26	Silty clay loam	CL, OL, OH, MH	A-7, A-6	0	100	100	95-100	95-100	30-55	10-25
	26-60	Silty clay loam	CL, ML	A-7, A-6	0	100	100	95-100	95-100	35-50	10-25
20C2, 20D2, 20D3, 20E2, 20E3------ Killduff	0-7	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-50	15-25
	7-38	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	15-25
	38-60	Silt loam, silty clay loam.	CL	A-6	0	100	100	100	95-100	30-40	10-20
24D2------------- Shelby	0-7	Loam-------------	CL	A-6	0	95-100	85-95	75-90	55-70	30-40	10-20
	7-45	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	45-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
24D3------------- Shelby	0-7	Clay loam--------	CL	A-6, A-7-6	0	90-95	85-95	75-90	55-70	35-45	15-25
	7-45	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	45-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
24E2------------- Shelby	0-7	Loam-------------	CL	A-6	0	95-100	85-95	75-90	55-70	30-40	10-20
	7-45	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	45-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
24E3------------- Shelby	0-7	Clay loam--------	CL	A-6, A-7-6	0	90-95	85-95	75-90	55-70	35-45	15-25
	7-45	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	45-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
24F2------------- Shelby	0-7	Loam-------------	CL	A-6	0	95-100	85-95	75-90	55-70	30-40	10-20
	7-45	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	45-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
41B, 41C, 41D---- Sparta	0-33	Loamy fine sand	SM	A-2, A-4	0	85-100	85-100	50-95	15-50	---	NP
	33-60	Loamy fine sand, fine sand, sand.	SP-SM, SM	A-2, A-3, A-4	0	85-100	85-100	50-95	5-50	---	NP
43--------------- Bremer	0-15	Silty clay loam	CH, CL	A-7	0	100	100	100	95-100	45-60	25-40
	15-49	Silty clay loam, silty clay.	CH, MH	A-7	0	100	100	100	95-100	50-65	20-35
	49-60	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	40-60	25-40

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
51---------------- Vesser	0-17	Silt loam--------	CL	A-6	0	100	100	98-100	95-100	30-40	10-20
	17-28	Silt loam--------	CL	A-6	0	100	100	98-100	95-100	30-40	10-20
	28-60	Silty clay loam	CL, CH	A-7	0	100	100	98-100	95-100	40-55	20-30
54---------------- Zook	0-18	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	18-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
55---------------- Nicollet	0-20	Loam-------------	OL, ML, CL	A-6, A-7	0	95-100	95-100	85-98	55-85	35-50	10-25
	20-33	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-95	55-80	35-50	15-25
	33-60	Loam-------------	CL, ML	A-6, A-4	0-5	95-100	90-100	75-90	50-75	30-40	5-15
62D2------------- Storden	0-8	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	8-60	Loam-------------	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
63C, 63E--------- Chelsea	0-8	Loamy fine sand	SM, SP-SM	A-2-4	0	100	100	65-80	10-35	---	NP
	8-60	Fine sand, sand, loamy sand.	SP, SM, SP-SM	A-3, A-2-4	0	100	100	65-80	3-15	---	NP
65F, 65G--------- Lindley	0-7	Loam-------------	CL-ML, CL	A-4, A-6	0	95-100	90-100	85-95	50-65	15-30	5-15
	7-50	Clay loam, loam	CL	A-6, A-7	0	95-100	90-100	85-95	55-75	30-45	15-25
	50-60	Loam, clay loam	CL	A-6	0	95-100	90-100	85-95	50-70	30-40	15-25
88---------------- Nevin	0-24	Silty clay loam	CL, OL	A-6, A-7	0	100	100	100	90-95	35-45	10-20
	24-47	Silty clay loam	CL	A-7	0	100	100	95-100	90-95	40-50	20-30
	47-60	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	90-95	40-50	20-30
93D2*, 93E2*:											
Shelby----------	0-7	Loam-------------	CL	A-6	0	95-100	85-95	75-90	55-70	30-40	10-20
	7-45	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	45-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
Adair-----------	0-6	Clay loam--------	CL	A-6	0	95-100	80-95	75-90	60-80	30-40	10-20
	6-60	Silty clay, clay, clay loam.	CL, CH	A-7	0	95-100	80-95	70-90	55-80	40-55	20-30
95---------------- Harps	0-18	Loam, clay loam	CL, CH	A-6, A-7	0-5	100	95-100	80-90	65-80	30-55	15-35
	18-43	Loam, clay loam, sandy clay loam.	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-60	15-35
	43-60	Loam-------------	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	10-25
107--------------- Webster	0-20	Silty clay loam	CL, CH	A-7, A-6	0-5	100	95-100	85-95	70-90	35-60	15-30
	20-39	Clay loam, silty clay loam, loam.	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	15-30
	39-60	Loam, sandy loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
118--------------- Garwin	0-17	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	45-55	20-30
	17-60	Silty clay loam	CH, CL	A-7	0	100	100	100	95-100	45-55	25-35
119--------------- Muscatine	0-19	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	15-25
	19-60	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	20-30
120, 120B, 120C, 120C2, 120D2, 120E2----------- Tama	0-16	Silty clay loam	ML	A-6, A-7	0	100	100	100	95-100	35-50	10-20
	16-47	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	15-25
	47-60	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	100	95-100	35-45	15-25
122--------------- Sperry	0-22	Silt loam--------	CL	A-6	0	100	100	100	95-100	30-40	10-20
	22-37	Silty clay loam, silty clay.	CH	A-7	0	100	100	100	95-100	50-65	25-35
	37-60	Silty clay loam, silt loam.	CL	A-7	0	100	100	100	95-100	40-50	20-30
133--------------- Colo	0-11	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	11-60	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
133+ Colo	0-11	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	95-100	95-100	25-40	5-15
	11-60	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
133B Colo	0-11	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	11-60	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
135 Coland	0-40	Silty clay loam	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	40-60	Clay loam, silty clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
138B, 138C, 138C2, 138D2, 138E2 Clarion	0-15	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	15-38	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	38-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
150 Hanska	0-13	Loam	ML, CL, CL-ML	A-4	0	98-100	95-100	80-95	50-65	<25	2-10
	13-34	Sandy loam, coarse sandy loam, loam.	SM, SM-SC, SC	A-4	0	98-100	95-100	65-80	35-50	<20	2-8
	34-60	Sand, coarse sand	SP-SM	A-3, A-1, A-2	0	95-100	85-100	45-70	5-10	<20	NP
162B, 162C, 162C2, 162D, 162D2, 162E2 Downs	0-12	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	100	95-100	25-35	5-15
	12-60	Silty clay loam, silt loam.	CL	A-7, A-6	0	100	100	100	95-100	35-45	15-25
163B, 163C, 163D, 163E, 163F Fayette	0-11	Silt loam	CL-ML, CL	A-4, A-6	0	100	100	100	95-100	25-35	5-15
	11-53	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	100	95-100	35-45	15-25
	53-60	Silt loam	CL	A-6	0	100	100	100	95-100	30-40	10-20
175B Dickinson	0-5	Fine sandy loam	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
	5-38	Fine sandy loam, sandy loam.	SM, SC, SM-SC	A-4	0	100	100	85-95	35-50	15-30	NP-10
	38-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM, SM-SC	A-2, A-3	0	100	100	80-95	5-20	10-20	NP-5
175C Dickinson	0-5	Fine sandy loam	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
	5-38	Fine sandy loam, sandy loam.	SM, SC, SM-SC	A-4	0	100	100	85-95	35-50	15-30	NP-10
	38-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM, SM-SC	A-2, A-3	0	100	100	80-95	5-20	10-20	NP-5
175D2 Dickinson	0-5	Fine sandy loam	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
	5-38	Fine sandy loam, sandy loam.	SM, SC, SM-SC	A-4	0	100	100	85-95	35-50	15-30	NP-10
	38-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM, SM-SC	A-2, A-3	0	100	100	80-95	5-20	10-20	NP-5
177, 177C2 Saude	0-14	Loam	CL	A-6	0	100	90-100	70-90	50-75	25-35	10-15
	14-27	Loam, sandy loam	CL, SC, CL-ML, SM-SC	A-4, A-6	0-5	85-95	80-95	70-85	36-60	20-30	5-15
	27-60	Loamy sand, gravelly loamy sand, sand.	SW, SM, GP, GM	A-1	2-10	50-90	50-85	20-40	3-25	---	NP

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
178---------------- Waukee	0-17	Loam----------------	CL	A-6	0	100	90-100	70-90	50-75	30-40	10-20
	17-40	Loam, sandy clay loam.	CL, SM-SC, SC, CL-ML	A-6, A-4	0-5	85-95	80-95	65-85	40-60	20-35	5-15
	40-60	Gravelly sand, loamy coarse sand, gravelly loamy sand.	SW, SM, SP-SM, SP	A-1	2-10	60-90	60-85	20-40	3-25	---	NP
179E, 179E2, 179F------------- Gara	0-11	Loam----------------	CL, CL-ML	A-4, A-6	0	95-100	85-95	75-85	55-70	20-30	5-15
	11-47	Clay loam----------	CL	A-6	0-5	90-95	85-95	70-85	55-75	30-40	15-25
	47-60	Loam, clay loam	CL	A-6, A-7	0-5	90-95	85-95	70-85	55-75	35-45	15-25
192D2------------- Adair	0-6	Clay loam----------	CL	A-6	0	95-100	80-95	75-90	60-80	30-40	10-20
	6-60	Silty clay, clay, clay loam.	CL, CH	A-7	0	95-100	80-95	70-90	55-80	40-55	20-30
201B*: Coland-----------	0-40	Silty clay loam, clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	40-60	Clay loam, silty clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
Terril-----------	0-32	Loam----------------	CL	A-4, A-6	0-5	100	95-100	70-90	60-80	25-40	8-15
	32-49	Loam, clay loam	CL	A-4, A-6	0-5	100	90-100	70-90	60-80	25-40	8-15
	49-60	Sand, gravelly sand, sandy loam.	SP-SM, SM	A-2-4	0-25	90-100	75-90	60-80	10-35	---	NP
220---------------- Nodaway	0-57	Silt loam----------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
	57-60	Silty clay loam	CL	A-6	0	100	95-100	95-100	90-100	25-40	10-25
222D2------------- Clarinda	0-14	Silty clay loam	CL	A-7	0	100	95-100	90-100	85-100	40-50	20-30
	14-53	Silty clay, clay	CH	A-7	0	100	95-100	85-100	80-100	55-70	30-40
	53-60	Clay, silty clay	CH	A-7	0	95-100	95-100	80-95	75-90	55-70	35-45
226---------------- Lawler	0-16	Loam----------------	CL, ML	A-6, A-7	0	100	90-100	70-90	55-75	35-45	10-20
	16-32	Loam, sandy clay loam, clay loam.	CL, SC	A-6	0-5	85-95	80-95	70-85	45-65	25-40	10-20
	32-60	Stratified sandy loam to gravelly coarse sand.	SW, GP, SP, SW-SM	A-1	2-10	50-90	50-85	20-40	3-10	---	NP
236C, 236C2, 236D2, 236E, 236F------------- Lester	0-9	Loam----------------	ML, CL	A-6, A-4	0	95-100	90-100	80-95	50-70	30-40	5-15
	9-42	Clay loam, loam	CL	A-7, A-6	0-5	95-100	90-100	80-95	55-75	35-50	15-25
	42-60	Loam, clay loam	CL, CL-ML	A-6, A-4	0-5	95-100	90-100	75-90	50-70	20-40	5-20
323C-------------- Terril	0-32	Loam----------------	CL	A-4, A-6	0-5	100	95-100	70-90	60-80	25-40	8-15
	32-49	Loam, clay loam	CL	A-4, A-6	0-5	100	90-100	70-90	60-80	25-40	8-15
	49-60	Sand, gravelly sand, sandy loam.	SP-SM, SM	A-2-4	0-25	90-100	75-90	60-80	10-35	---	NP
377C, 377C2, 377D2------------ Dinsdale	0-18	Silty clay loam	ML, CL	A-6, A-7	0	100	100	100	95-100	30-50	10-20
	18-29	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	15-25
	29-60	Loam, clay loam, sandy clay loam.	CL	A-6	0-5	90-95	85-90	75-85	55-65	25-35	10-20
420B, 420C2------- Tama	0-16	Silty clay loam	ML	A-6, A-7	0	100	100	100	95-100	35-50	10-20
	16-47	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	15-25
	47-60	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	100	95-100	35-45	15-25
428B-------------- Ely	0-26	Silty clay loam	CL, OL, OH, MH	A-7, A-6	0	100	100	95-100	95-100	30-55	10-25
	26-60	Silty clay loam	CL, ML	A-7, A-6	0	100	100	95-100	95-100	35-50	10-25

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
430-------------- Ackmore	0-27	Silt loam--------	CL, ML	A-4, A-6, A-7	0	100	100	95-100	85-100	25-50	8-20
	27-60	Silty clay loam, silt loam.	CH, CL, MH, ML	A-7, A-6	0	100	100	95-100	85-100	35-60	15-30
442B*, 442C2*, 442E2*: Dickinson------	0-5	Fine sandy loam	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
	5-38	Fine sandy loam, sandy loam.	SM, SC, SM-SC	A-4	0	100	100	85-95	35-50	15-30	NP-10
	38-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM, SM-SC	A-2, A-3	0	100	100	80-95	5-20	10-20	NP-5
Sparta---------	0-33	Loamy fine sand	SM	A-2, A-4	0	85-100	85-100	50-95	15-50	---	NP
	33-60	Loamy fine sand, fine sand, sand.	SP-SM, SM	A-2, A-3, A-4	0	85-100	85-100	50-95	5-50	---	NP
Tama-----------	0-16	Silty clay loam	ML	A-6, A-7	0	100	100	100	95-100	35-50	10-20
	16-47	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	15-25
	47-60	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	100	95-100	35-45	15-25
462B------------- Downs	0-12	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	100	95-100	25-35	5-15
	12-60	Silty clay loam, silt loam.	CL	A-7, A-6	0	100	100	100	95-100	35-45	15-25
484-------------- Lawson	0-30	Silty clay loam	CL	A-6	0	100	100	90-100	80-100	30-40	10-20
	30-60	Silty clay loam, silt loam.	CL	A-6	0	100	100	90-100	80-100	20-40	10-25
485-------------- Spillville	0-40	Loam-------------	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
	40-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
507-------------- Canisteo	0-6	Silty clay loam	CL	A-7, A-6	0	100	100	90-100	85-100	35-50	15-25
	6-40	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	40-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	60-75	30-40	12-20
536-------------- Hanlon	0-31	Fine sandy loam	SM-SC, SC, SM	A-4	0	100	100	75-80	35-50	25-35	5-10
	31-60	Sandy loam, fine sandy loam, loamy fine sand.	SM-SC, SC	A-4, A-2	0	100	100	75-80	25-40	15-25	5-10
595-------------- Harpster	0-20	Silty clay loam	CL, CH	A-7	0	100	95-100	95-100	90-100	45-60	20-35
	20-42	Silty clay loam, silt loam, loam.	CL, CH	A-7	0	100	95-100	95-100	80-100	40-60	20-35
	42-60	Stratified sandy loam to clay loam.	CL, CL-ML, SC, SM-SC	A-6, A-4, A-7	0	100	95-100	95-100	45-95	20-50	5-25
683C2, 683D, 683D2, 683E, 683E2----------- Liscomb	0-12	Loam-------------	CL	A-6	0	100	100	85-95	60-80	30-40	10-20
	12-42	Loam, sandy clay loam, clay loam.	CL, SC	A-6	0-5	95-100	90-95	85-95	45-70	30-40	10-20
	42-60	Loam, sandy clay loam.	CL, SC	A-6	0-5	95-100	90-95	85-95	45-70	30-40	10-20
688-------------- Koszta	0-14	Silt loam--------	CL	A-6	0	100	100	95-100	95-100	30-40	10-20
	14-60	Silty clay loam	CL	A-7	0	100	100	95-100	95-100	40-50	20-30
1133------------- Colo	0-11	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	11-60	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
1220------------- Nodaway	0-57	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
	57-60	Silty clay loam	CL	A-6	0	100	95-100	95-100	90-100	25-40	10-25

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
1485 Spillville	0-40	Loam	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
	40-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
1936*:											
Colo	0-11	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	11-60	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
Hanlon	0-31	Fine sandy loam	SM-SC, SC, SM	A-4	0	100	100	75-80	35-50	25-35	5-10
	31-60	Sandy loam, fine sandy loam, loamy fine sand.	SM-SC, SC	A-4, A-2	0	100	100	75-80	25-40	15-25	5-10
Lawson	0-30	Silty clay loam	CL	A-6	0	100	100	90-100	80-100	30-40	10-20
	30-60	Silty clay loam, silt loam.	CL	A-6	0	100	100	90-100	80-100	20-40	10-25
4011B*:											
Colo	0-11	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	11-60	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
Ely	0-26	Silty clay loam	CL, OL, OH, MH	A-7, A-6	0	100	100	95-100	95-100	30-55	10-25
	26-60	Silty clay loam	CL, ML	A-7, A-6	0	100	100	95-100	95-100	35-50	10-25
Urban land.											
4119*:											
Muscatine	0-19	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	15-25
	19-60	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	20-30
Urban land.											
4120B*, 4120C*:											
Tama	0-16	Silty clay loam	ML	A-6, A-7	0	100	100	100	95-100	35-50	10-20
	16-47	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	15-25
	47-60	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	100	95-100	35-45	15-25
Urban land.											
4133*:											
Colo	0-11	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	11-60	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
Urban land.											
5010*, 5030*. Pits											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
5B*:											
Ackmore----------	0-27	25-30	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.37	5	6	1-3
	27-60	26-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.8	High---------	0.37			
Colo------------	0-11	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High---------	0.28	5	7	5-7
	11-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High---------	0.28			
6---------------- Okoboji	0-28	35-42	1.25-1.30	0.2-0.6	0.21-0.23	6.6-7.8	High---------	0.37	5	4	9-11
	28-60	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High---------	0.37			
7---------------- Wiota	0-26	24-32	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	7	3-4
	26-49	30-36	1.30-1.40	0.6-2.0	0.18-0.20	5.1-6.5	Moderate-----	0.43			
	49-60	28-34	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	Moderate-----	0.43			
8B, 8C----------- Judson	0-34	25-32	1.30-1.35	0.6-2.0	0.21-0.23	6.1-7.3	Moderate-----	0.28	5	7	3-5
	34-60	30-35	1.35-1.45	0.6-2.0	0.21-0.23	6.1-7.3	Moderate-----	0.43			
11B*:											
Colo------------	0-11	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High---------	0.28	5	7	5-7
	11-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High---------	0.28			
Ely-------------	0-26	25-30	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	7	5-6
	26-60	28-32	1.30-1.40	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.43			
20C2, 20D2, 20D3, 20E2, 20E3------ Killduff	0-7	28-33	1.30-1.35	0.6-2.0	0.21-0.23	6.6-7.3	Moderate-----	0.32	5	7	<3
	7-38	30-35	1.35-1.40	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.43			
	38-60	26-32	1.40-1.45	0.6-2.0	0.20-0.22	6.6-7.8	Moderate-----	0.43			
24D2------------- Shelby	0-7	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.28	5	6	1-2
	7-45	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.6-7.8	Moderate-----	0.28			
	45-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
24D3------------- Shelby	0-7	27-35	1.50-1.55	0.2-0.6	0.16-0.18	5.6-7.3	Moderate-----	0.28	4	6	<1
	7-45	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.6-7.8	Moderate-----	0.28			
	45-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
24E2------------- Shelby	0-7	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.28	5	6	.5-1.5
	7-45	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.6-7.8	Moderate-----	0.28			
	45-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
24E3------------- Shelby	0-7	27-35	1.50-1.55	0.2-0.6	0.16-0.18	5.6-7.3	Moderate-----	0.28	4	6	<1
	7-45	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.6-7.8	Moderate-----	0.28			
	45-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
24F2------------- Shelby	0-7	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.28	5	6	.5-1.5
	7-45	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.6-7.8	Moderate-----	0.28			
	45-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
41B, 41C, 41D---- Sparta	0-33	3-10	1.20-1.40	2.0-6.0	0.09-0.12	5.1-7.3	Low----------	0.17	5	2	.5-2
	33-60	1-8	1.40-1.60	6.0-20	0.05-0.11	5.1-6.5	Low----------	0.17			
43--------------- Bremer	0-15	25-32	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	7	5-7
	15-49	35-42	1.30-1.40	0.2-0.6	0.15-0.17	6.1-6.5	High---------	0.28			
	49-60	32-38	1.40-1.45	0.2-0.6	0.18-0.20	6.1-6.5	High---------	0.28			
51--------------- Vesser	0-17	20-26	1.30-1.35	0.6-2.0	0.20-0.24	5.6-7.3	Moderate-----	0.32	5	7	3-4
	17-28	16-22	1.35-1.40	0.6-2.0	0.18-0.22	5.1-6.0	Moderate-----	0.43			
	28-60	30-36	1.40-1.45	0.6-2.0	0.17-0.21	5.6-6.5	Moderate-----	0.43			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm^3	In/hr	In/in	pH					Pct
54----------------	0-18	32-38	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	High----------	0.28	5	7	5-7
Zook	18-60	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	High----------	0.28			
55----------------	0-20	24-35	1.15-1.25	0.6-2.0	0.17-0.22	5.6-7.3	Moderate------	0.24	5	6	5-6
Nicollet	20-33	24-35	1.25-1.35	0.6-2.0	0.15-0.19	5.6-7.8	Moderate------	0.32			
	33-60	22-28	1.35-1.45	0.6-2.0	0.14-0.19	7.4-7.8	Low-----------	0.32			
62D2--------------	0-8	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low-----------	0.28	5	4L	.5-2
Storden	8-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37			
63C, 63E----------	0-8	8-15	1.50-1.55	6.0-20	0.10-0.15	5.6-7.3	Low-----------	0.17	5	2	<.5
Chelsea	8-60	5-10	1.55-1.70	6.0-20	0.06-0.08	5.1-5.5	Low-----------	0.17			
65F, 65G----------	0-7	18-27	1.20-1.40	0.6-2.0	0.16-0.18	4.5-7.3	Low-----------	0.32	5	6	.5-1
Lindley	7-50	25-35	1.50-1.75	0.2-0.6	0.14-0.18	4.5-6.5	Moderate------	0.32			
	50-60	18-32	1.75-1.85	0.2-0.6	0.12-0.16	6.1-7.8	Moderate------	0.32			
88----------------	0-24	26-29	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate------	0.32	5	7	4-6
Nevin	24-47	30-35	1.30-1.40	0.6-2.0	0.18-0.20	6.1-6.5	Moderate------	0.43			
	47-60	25-36	1.40-1.45	0.6-2.0	0.18-0.20	6.6-7.3	Moderate------	0.43			
93D2*, 93E2*:											
Shelby------------	0-7	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate------	0.28	5	6	.5-2
	7-45	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.6-7.8	Moderate------	0.28			
	45-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate------	0.37			
Adair-------------	0-6	27-35	1.45-1.50	0.2-0.6	0.17-0.19	5.6-7.3	Moderate------	0.32	2	6	1-3
	6-60	38-50	1.50-1.60	0.06-0.2	0.13-0.16	5.1-6.5	High----------	0.32			
95----------------	0-18	25-35	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate------	0.24	5	4L	4-6
Harps	18-43	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	Moderate------	0.32			
	43-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.9-8.4	Moderate------	0.32			
107---------------	0-20	26-36	1.35-1.40	0.6-2.0	0.19-0.21	6.6-7.3	Moderate------	0.24	5	6	6-7
Webster	20-39	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	Moderate------	0.32			
	39-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate------	0.32			
118---------------	0-17	30-35	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	High----------	0.28	5	7	6-7
Garwin	17-60	28-34	1.28-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High----------	0.28			
119---------------	0-19	28-30	1.30-1.35	0.6-2.0	0.22-0.24	5.1-7.3	Moderate------	0.28	5	6	5-6
Muscatine	19-60	30-34	1.28-1.35	0.6-2.0	0.18-0.20	5.1-7.3	Moderate------	0.43			
120, 120B, 120C, 120C2, 120D2, 120E2------------	0-16	24-29	1.25-1.30	0.6-2.0	0.22-0.24	5.1-7.3	Moderate------	0.32	5	7	1-5
Tama	16-47	28-34	1.30-1.35	0.6-2.0	0.18-0.20	5.1-6.0	Moderate------	0.43			
	47-60	22-28	1.35-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate------	0.43			
122---------------	0-22	18-22	1.35-1.40	0.6-2.0	0.22-0.24	5.6-7.3	Moderate------	0.28	5	6	3-4
Sperry	22-37	38-45	1.40-1.45	0.06-0.2	0.14-0.16	5.1-6.5	High----------	0.43			
	37-60	26-34	1.45-1.50	0.2-0.6	0.19-0.21	5.6-6.5	High----------	0.43			
133---------------	0-11	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High----------	0.28	5	7	5-7
Colo	11-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High----------	0.28			
133+--------------	0-11	20-26	1.25-1.30	0.6-2.0	0.22-0.24	6.6-7.3	Moderate------	0.28	5	6	3-5
Colo	11-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High----------	0.28			
133B--------------	0-11	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High----------	0.28	5	7	5-7
Colo	11-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High----------	0.28			
135---------------	0-40	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High----------	0.28	5	7	5-7
Coland	40-60	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High----------	0.28			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
138B, 138C, 138C2, 138D2, 138E2 Clarion	0-15	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.28	5	6	.5-4
	15-38	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low	0.37			
	38-60	12-22	1.70-1.80	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
150 Hanska	0-13	12-18	1.50-1.55	2.0-6.0	0.20-0.22	6.1-7.8	Low	0.28	4	5	4-6
	13-34	10-15	1.55-1.65	2.0-6.0	0.10-0.13	6.1-7.3	Low	0.28			
	34-60	2-10	1.60-1.70	6.0-20	0.03-0.05	6.6-7.8	Low	0.17			
162B, 162C, 162C2, 162D, 162D2, 162E2 Downs	0-12	18-24	1.25-1.30	0.6-2.0	0.21-0.23	5.1-7.3	Low	0.32	5-4	6	.5-3
	12-60	26-34	1.30-1.35	0.6-2.0	0.18-0.20	4.5-6.0	Moderate	0.43			
163B, 163C, 163D, 163E, 163F Fayette	0-11	15-25	1.30-1.35	0.6-2.0	0.20-0.22	5.1-7.3	Low	0.37	5	6	<2
	11-53	30-35	1.30-1.45	0.6-2.0	0.18-0.20	4.5-6.0	Moderate	0.37			
	53-60	22-26	1.45-1.50	0.6-2.0	0.18-0.20	5.1-7.8	Moderate	0.37			
175B Dickinson	0-5	12-18	1.50-1.55	2.0-6.0	0.12-0.15	5.6-7.3	Low	0.20	4	3	1-2
	5-38	10-15	1.45-1.55	2.0-6.0	0.12-0.15	5.1-6.5	Low	0.20			
	38-60	5-10	1.55-1.65	6.0-20	0.08-0.10	5.1-6.5	Low	0.20			
175C Dickinson	0-5	12-18	1.50-1.55	2.0-6.0	0.12-0.15	5.6-7.3	Low	0.20	4	3	1-2
	5-38	10-15	1.45-1.55	2.0-6.0	0.12-0.15	5.1-6.5	Low	0.20			
	38-60	5-10	1.55-1.65	6.0-20	0.08-0.10	5.1-6.5	Low	0.20			
175D2 Dickinson	0-5	12-18	1.50-1.55	2.0-6.0	0.12-0.15	5.6-7.3	Low	0.20	4	3	<.5
	5-38	10-15	1.45-1.55	2.0-6.0	0.12-0.15	5.1-6.5	Low	0.20			
	38-60	5-10	1.55-1.65	6.0-20	0.08-0.10	5.1-6.5	Low	0.20			
177, 177C2 Saude	0-14	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.28	4	5	1-4
	14-27	12-20	1.40-1.50	0.6-6.0	0.15-0.19	5.1-6.0	Low	0.28			
	27-60	2-8	1.50-1.75	>20	0.02-0.06	5.1-6.5	Very low	0.10			
178 Waukee	0-17	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.24	4	6	3-4
	17-40	20-26	1.40-1.50	0.6-2.0	0.15-0.19	4.5-6.5	Low	0.32			
	40-60	2-8	1.50-1.75	>20	0.02-0.06	5.6-7.3	Low	0.10			
179E, 179E2, 179F Gara	0-11	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate	0.28	5	6	.5-2
	11-47	30-38	1.55-1.75	0.2-0.6	0.16-0.18	4.5-6.5	Moderate	0.28			
	47-60	24-38	1.75-1.85	0.2-0.6	0.16-0.18	6.6-7.8	Moderate	0.37			
192D2 Adair	0-6	27-35	1.45-1.50	0.2-0.6	0.17-0.19	5.6-7.3	Moderate	0.32	2	6	1-3
	6-60	38-50	1.50-1.60	0.06-0.2	0.13-0.16	5.1-6.5	High	0.32			
201B*:											
Coland	0-40	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High	0.28	5	7	4-6
	40-60	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High	0.28			
Terril	0-32	20-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low	0.32	5	6	4-5
	32-49	22-30	1.40-1.65	0.6-2.0	0.16-0.18	6.6-7.3	Low	0.32			
	49-60	2-8	1.65-1.75	6.0-20	0.05-0.07	6.6-8.4	Low	0.10			
220 Nodaway	0-57	18-27	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate	0.37	5	6	1-2
	57-60	27-30	1.30-1.40	0.6-2.0	0.20-0.23	6.1-7.3	Moderate	0.37			
222D2 Clarinda	0-14	30-38	1.45-1.50	0.2-0.6	0.17-0.19	5.1-7.3	Moderate	0.37	3	7	.5-2
	14-53	40-60	1.45-1.60	<0.06	0.14-0.16	5.1-6.5	High	0.37			
	53-60	40-60	1.55-1.75	<0.06	0.14-0.16	5.6-7.3	High	0.37			
226 Lawler	0-16	18-28	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.28	4	6	4-5
	16-32	20-28	1.45-1.60	0.6-2.0	0.16-0.18	5.1-6.5	Low	0.28			
	32-60	2-12	1.60-1.75	>20	0.02-0.04	5.1-6.5	Low	0.10			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodi-bility group	Organic matter
								K	T		
	In	Pct	G/cm^3	In/hr	In/in	pH					Pct
236C, 236C2, 236D2, 236E, 236F----------- Lester	0-9	15-27	1.30-1.40	0.6-2.0	0.20-0.22	5.6-6.5	Low-----------	0.28	5	6	.5-3
	9-42	20-35	1.45-1.55	0.6-2.0	0.15-0.19	5.1-6.5	Moderate-----	0.28			
	42-60	20-30	1.55-1.75	0.6-2.0	0.14-0.19	6.6-7.8	Low-----------	0.37			
323C------------- Terril	0-32	20-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low-----------	0.32	5	6	4-5
	32-49	22-30	1.40-1.65	0.6-2.0	0.16-0.18	6.6-7.3	Low-----------	0.32			
	49-60	2-8	1.65-1.75	6.0-20	0.05-0.07	6.6-8.4	Low-----------	0.10			
377C, 377C2, 377D2----------- Dinsdale	0-18	25-29	1.25-1.30	0.6-2.0	0.21-0.23	5.1-7.3	Moderate-----	0.32	5	7	1-4
	18-29	30-34	1.30-1.35	0.6-2.0	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	29-60	20-28	1.65-1.80	0.6-2.0	0.17-0.19	5.6-8.4	Low-----------	0.43			
420B, 420C2------- Tama	0-16	24-29	1.25-1.30	0.6-2.0	0.22-0.24	5.1-7.3	Moderate-----	0.32	5	7	2-4
	16-47	28-34	1.30-1.35	0.6-2.0	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	47-60	22-28	1.35-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
428B------------- Ely	0-26	25-30	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	7	4-6
	26-60	28-32	1.30-1.40	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.43			
430-------------- Ackmore	0-27	25-30	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.37	5	6	1-3
	27-60	26-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.8	High----------	0.37			
442B*, 442C2*, 442E2*: Dickinson-------	0-5	12-18	1.50-1.55	2.0-6.0	0.12-0.15	5.6-7.3	Low-----------	0.20	4	3	<2
	5-38	10-15	1.45-1.55	2.0-6.0	0.12-0.15	5.1-6.5	Low-----------	0.20			
	38-60	5-10	1.55-1.65	6.0-20	0.08-0.10	5.1-6.5	Low-----------	0.20			
Sparta----------	0-33	3-10	1.20-1.40	2.0-6.0	0.09-0.12	5.1-7.3	Low-----------	0.17	5	2	<2
	33-60	1-8	1.40-1.60	6.0-20	0.05-0.11	5.1-6.5	Low-----------	0.17			
Tama------------	0-16	24-29	1.25-1.30	0.6-2.0	0.22-0.24	5.1-7.3	Moderate-----	0.32	5	7	2-4
	16-47	28-34	1.30-1.35	0.6-2.0	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	47-60	22-28	1.35-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
462B------------- Downs	0-12	18-24	1.25-1.30	0.6-2.0	0.21-0.23	5.1-7.3	Low-----------	0.32	5-4	6	2-3
	12-60	26-34	1.30-1.35	0.6-2.0	0.18-0.20	4.5-6.0	Moderate-----	0.43			
484-------------- Lawson	0-30	27-32	1.20-1.55	0.6-2.0	0.22-0.24	6.1-7.8	Low-----------	0.32	5	5	4-6
	30-60	18-30	1.55-1.65	0.6-2.0	0.18-0.20	6.1-7.8	Moderate-----	0.43			
485-------------- Spillville	0-40	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6	4-5
	40-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low-----------	0.28			
507-------------- Canisteo	0-6	18-35	1.20-1.30	0.6-2.0	0.20-0.22	7.4-8.4	Moderate-----	0.32	5	4L	6-7
	6-40	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	Moderate-----	0.32			
	40-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low-----------	0.32			
536-------------- Hanlon	0-31	12-15	1.50-1.70	2.0-6.0	0.16-0.18	6.6-7.3	Low-----------	0.20	5	3	2-4
	31-60	5-10	1.70-1.75	2.0-6.0	0.11-0.13	5.6-7.3	Low-----------	0.20			
595-------------- Harpster	0-20	22-35	1.05-1.25	0.6-2.0	0.21-0.24	7.4-8.4	Moderate-----	0.28	5	4L	5-6
	20-42	25-35	1.20-1.50	0.6-2.0	0.17-0.22	7.4-8.4	Moderate-----	0.28			
	42-60	15-30	1.40-1.60	0.6-2.0	0.11-0.22	7.4-8.4	Low-----------	0.28			
683C2, 683D, 683D2, 683E, 683E2----------- Liscomb	0-12	20-25	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low-----------	0.32	5	6	1-3
	12-42	20-28	1.45-1.65	0.6-2.0	0.17-0.19	5.6-7.3	Low-----------	0.32			
	42-60	20-24	1.65-1.80	0.6-2.0	0.15-0.17	6.1-7.8	Low-----------	0.32			
688-------------- Koszta	0-14	18-24	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	Moderate-----	0.32	5	7	2-3
	14-60	28-35	1.30-1.45	0.6-2.0	0.15-0.19	5.1-7.3	Moderate-----	0.43			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
1133-------------	0-11	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High---------	0.28	5	7	4-6
Colo	11-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High---------	0.28			
1220-------------	0-57	18-27	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate-----	0.37	5	6	1-2
Nodaway	57-60	27-30	1.30-1.40	0.6-2.0	0.20-0.23	6.1-7.3	Moderate-----	0.37			
1485-------------	0-40	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6	3-5
Spillville	40-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low----------	0.28			
1936*:											
Colo------------	0-11	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High---------	0.28	5	7	5-7
	11-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High---------	0.28			
Hanlon----------	0-31	12-15	1.50-1.70	2.0-6.0	0.16-0.18	6.6-7.3	Low----------	0.20	5	3	2-4
	31-60	5-10	1.70-1.75	2.0-6.0	0.11-0.13	5.6-7.3	Low----------	0.20			
Lawson----------	0-30	27-32	1.20-1.55	0.6-2.0	0.22-0.24	6.1-7.8	Low----------	0.32	5	5	4-6
	30-60	18-30	1.55-1.65	0.6-2.0	0.18-0.20	6.1-7.8	Moderate-----	0.43			
4011B*:											
Colo------------	0-11	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High---------	0.28	5	7	5-7
	11-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High---------	0.28			
Ely-------------	0-26	25-30	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	7	5-6
	26-60	28-32	1.30-1.40	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.43			
Urban land.											
4119*:											
Muscatine-------	0-19	28-30	1.30-1.35	0.6-2.0	0.22-0.24	5.1-7.3	Moderate-----	0.28	5	6	4-5
	19-60	30-34	1.28-1.35	0.6-2.0	0.18-0.20	5.1-7.3	Moderate-----	0.43			
Urban land.											
4120B*, 4120C*:											
Tama------------	0-16	24-29	1.25-1.30	0.6-2.0	0.22-0.24	5.1-7.3	Moderate-----	0.32	5	7	3-4
	16-47	28-34	1.30-1.35	0.6-2.0	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	47-60	22-28	1.35-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
Urban land.											
4133*:											
Colo------------	0-11	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High---------	0.28	5	7	5-7
	11-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High---------	0.28			
Urban land.											
5010*, 5030*. Pits											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
5B*:												
Ackmore	B	Frequent	Very brief or brief.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High	High	Low.
Colo	B/D	Frequent	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High	High	Moderate.
6 Okoboji	B/D	None	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High	High	Low.
7 Wiota	B	Rare	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.
8B, 8C Judson	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Low.
11B*:												
Colo	B/D	Frequent	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High	High	Moderate.
Ely	B	None	---	---	2.0-4.0	Apparent	Nov-Jul	>60	---	High	High	Moderate.
20C2, 20D2, 20D3, 20E2, 20E3 Killduff	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.
24D2, 24D3, 24E2, 24E3, 24F2 Shelby	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
41B, 41C, 41D Sparta	A	None	---	---	>6.0	---	---	>60	---	Low	Low	Moderate.
43 Bremer	C	Rare	---	---	1.0-2.0	Apparent	Nov-Jul	>60	---	High	Moderate	Moderate.
51 Vesser	C	Occasional	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High	High	Moderate.
54 Zook	C/D	Occasional	Brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-May	>60	---	High	High	Moderate.
55 Nicollet	B	None	---	---	2.5-5.0	Apparent	Apr-May	>60	---	High	High	Low.
62D2 Storden	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Low.
63C, 63E Chelsea	A	None	---	---	>6.0	---	---	>60	---	Low	Low	Low.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Bedrock: Depth	Bedrock: Hardness	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft			In				
65F, 65G----------- Lindley	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
88----------------- Nevin	B	Rare---------	---	---	2.0-4.0	Apparent	Nov-Jul	>60	---	High------	High------	Low.
93D2*, 93E2*:												
Shelby------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Adair-------------	D	None---------	---	---	1.0-3.0	Perched	Nov-Jul	>60	---	High------	High------	Moderate.
95----------------- Harps	B/D	None---------	---	---	1.0-3.0	Apparent	Nov-Jun	>60	---	High------	High------	Low.
107---------------- Webster	B/D	None---------	---	---	1.0-2.0	Apparent	Nov-Jul	>60	---	High------	High------	Low.
118---------------- Garwin	B/D	None---------	---	---	1.0-2.0	Apparent	Nov-Jul	>60	---	High------	High------	Moderate.
119---------------- Muscatine	B	None---------	---	---	2.0-4.0	Apparent	Nov-Jul	>60	---	High------	High------	Moderate.
120, 120B, 120C, 120C2, 120D2, 120E2------------ Tama	B	None---------	---	---	>6.0	---	---	>60	---	High------	Moderate	Moderate.
122---------------- Sperry	C/D	None---------	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High------	High------	Moderate.
133---------------- Colo	B/D	Occasional	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High------	High------	Moderate.
133+--------------- Colo	B/D	Frequent----	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High------	High------	Moderate.
133B--------------- Colo	B/D	Occasional	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High------	High------	Moderate.
135---------------- Coland	B/D	Occasional	Brief------	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High------	High------	Low.
138B, 138C, 138C2, 138D2, 138E2----- Clarion	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low-------	Low.
150---------------- Hanska	C	None to rare	---	---	0-3.0	Apparent	Nov-Jun	>60	---	High------	High------	Low.
162B, 162C, 162C2, 162D, 162D2, 162E2------------ Downs	B	None---------	---	---	>6.0	---	---	>60	---	High------	Moderate	Moderate.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
163B, 163C, 163D, 163E, 163F-------- Fayette	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
175B, 175C, 175D2- Dickinson	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Moderate.
177, 177C2-------- Saude	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Moderate.
178--------------- Waukee	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Moderate.
179E, 179E2, 179F- Gara	C	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
192D2------------- Adair	D	None--------	---	---	1.0-3.0	Perched	Nov-Jul	>60	---	High-----	High-----	Moderate.
201B*:												
Coland-----------	B/D	Frequent----	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
Terril-----------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
220--------------- Nodaway	B	Occasional	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	>60	---	High-----	Moderate	Low.
222D2------------- Clarinda	D	None--------	---	---	1.0-3.0	Perched	Nov-Jul	>60	---	High-----	High-----	Moderate.
226--------------- Lawler	B	None--------	---	---	2.0-4.0	Apparent	Nov-May	>60	---	High-----	High-----	Moderate.
236C, 236C2, 236D2, 236E, 236F------------- Lester	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Moderate.
323C-------------- Terril	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
377C, 377C2, 377D2------------ Dinsdale	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
420B, 420C2------- Tama	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
428B-------------- Ely	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
430--------------- Ackmore	B	Frequent----	Very brief to brief.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
442B*, 442C2*, 442E2*:												
Dickinson--------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low-------	Moderate.
Sparta-----------	A	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	Moderate.
Tama-------------	B	None---------	---	---	>6.0	---	---	>60	---	High------	Moderate	Moderate.
462B--------------- Downs	B	None---------	---	---	>6.0	---	---	>60	---	High------	Moderate	Moderate.
484---------------- Lawson	C	Occasional	Brief------	Mar-Nov	1.0-3.0	Apparent	Nov-May	>60	---	High------	Moderate	Low.
485---------------- Spillville	B	Occasional	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	Moderate	High------	Moderate.
507---------------- Canisteo	C/D	None---------	---	---	1.0-3.0	Apparent	Oct-Jul	>60	---	High------	High------	Low.
536---------------- Hanlon	B	Frequent-----	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jun	>60	---	Moderate	Moderate	Low.
595---------------- Harpster	B/D	Occasional	Brief------	Mar-Jun	0-2.0	Apparent	Feb-Jun	>60	---	High------	High------	Low.
683C2, 683D, 683D2, 683E, 683E2-------------- Liscomb	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
688---------------- Koszta	B	Rare---------	---	---	2.0-3.0	Apparent	Nov-Jul	>60	---	High------	Moderate	Moderate.
1133--------------- Colo	B/D	Frequent-----	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High------	High------	Moderate.
1220--------------- Nodaway	B	Frequent-----	Very brief or brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	>60	---	High------	Moderate	Low.
1485--------------- Spillville	B	Frequent-----	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	Moderate	High------	Moderate.
1936*:												
Colo--------------	B/D	Frequent-----	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High------	High------	Moderate.
Hanlon------------	B	Frequent-----	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jun	>60	---	Moderate	Moderate	Low.
Lawson------------	C	Frequent-----	Brief------	Mar-Nov	1.0-3.0	Apparent	Nov-May	>60	---	High------	Moderate	Low.
4011B*:												
Colo--------------	B/D	Frequent-----	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High------	High------	Moderate.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
4011B*:												
Ely	B	None	---	---	2.0-4.0	Apparent	Nov-Jul	>60	---	High	High	Moderate.
Urban land.												
4119*:												
Muscatine	B	None	---	---	2.0-4.0	Apparent	Nov-Jul	>60	---	High	High	Moderate.
Urban land.												
4120B*, 4120C*:												
Tama	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.
Urban land.												
4133*:												
Colo	B/D	Occasional	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High	High	Moderate.
Urban land.												
5010*, 5030*. Pits												

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
Ackmore	Fine-silty, mixed, nonacid, mesic Aeric Fluvaquents
*Adair	Fine, montmorillonitic, mesic Aquic Argiudolls
Bremer	Fine, montmorillonitic, mesic Typic Argiaquolls
Canisteo	Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls
Chelsea	Mixed, mesic Alfic Udipsamments
*Clarinda	Fine, montmorillonitic, mesic, sloping Typic Argiaquolls
Clarion	Fine-loamy, mixed, mesic Typic Hapludolls
Coland	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
Dickinson	Coarse-loamy, mixed, mesic Typic Hapludolls
Dinsdale	Fine-silty, mixed, mesic Typic Argiudolls
Downs	Fine-silty, mixed, mesic Mollic Hapludalfs
Ely	Fine-silty, mixed, mesic Cumulic Hapludolls
Fayette	Fine-silty, mixed, mesic Typic Hapludalfs
Gara	Fine-loamy, mixed, mesic Mollic Hapludalfs
Garwin	Fine-silty, mixed, mesic Typic Haplaquolls
Hanlon	Coarse-loamy, mixed, mesic Cumulic Hapludolls
Hanska	Coarse-loamy, mixed, mesic Typic Haplaquolls
Harps	Fine-loamy, mesic Typic Calciaquolls
Harpster	Fine-silty, mesic Typic Calciaquolls
Judson	Fine-silty, mixed, mesic Cumulic Hapludolls
Killduff	Fine-silty, mixed, mesic Dystric Eutrochrepts
Koszta	Fine-silty, mixed, mesic Udollic Ochraqualfs
Lawler	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Aquic Hapludolls
Lawson	Fine-silty, mixed, mesic Cumulic Hapludolls
Lester	Fine-loamy, mixed, mesic Mollic Hapludalfs
Lindley	Fine-loamy, mixed, mesic Typic Hapludalfs
Liscomb	Fine-loamy, mixed, mesic Typic Hapludolls
Muscatine	Fine-silty, mixed, mesic Aquic Hapludolls
Nevin	Fine-silty, mixed, mesic Aquic Argiudolls
Nicollet	Fine-loamy, mixed, mesic Aquic Hapludolls
Nodaway	Fine-silty, mixed, nonacid, mesic Mollic Udifluvents
Okoboji	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Saude	Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Shelby	Fine-loamy, mixed, mesic Typic Argiudolls
Sparta	Sandy, mixed, mesic Entic Hapludolls
Sperry	Fine, montmorillonitic, mesic Typic Argialbolls
Spillville	Fine-loamy, mixed, mesic Cumulic Hapludolls
Storden	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Tama	Fine-silty, mixed, mesic Typic Argiudolls
Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls
Vesser	Fine-silty, mixed, mesic Argiaquic Argialbolls
Waukee	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Webster	Fine-loamy, mixed, mesic Typic Haplaquolls
Wiota	Fine-silty, mixed, mesic Typic Argiudolls
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

☆U.S. GOVERNMENT PRINTING OFFICE : 1981—344-934/1025

NRCS Accessibility Statement

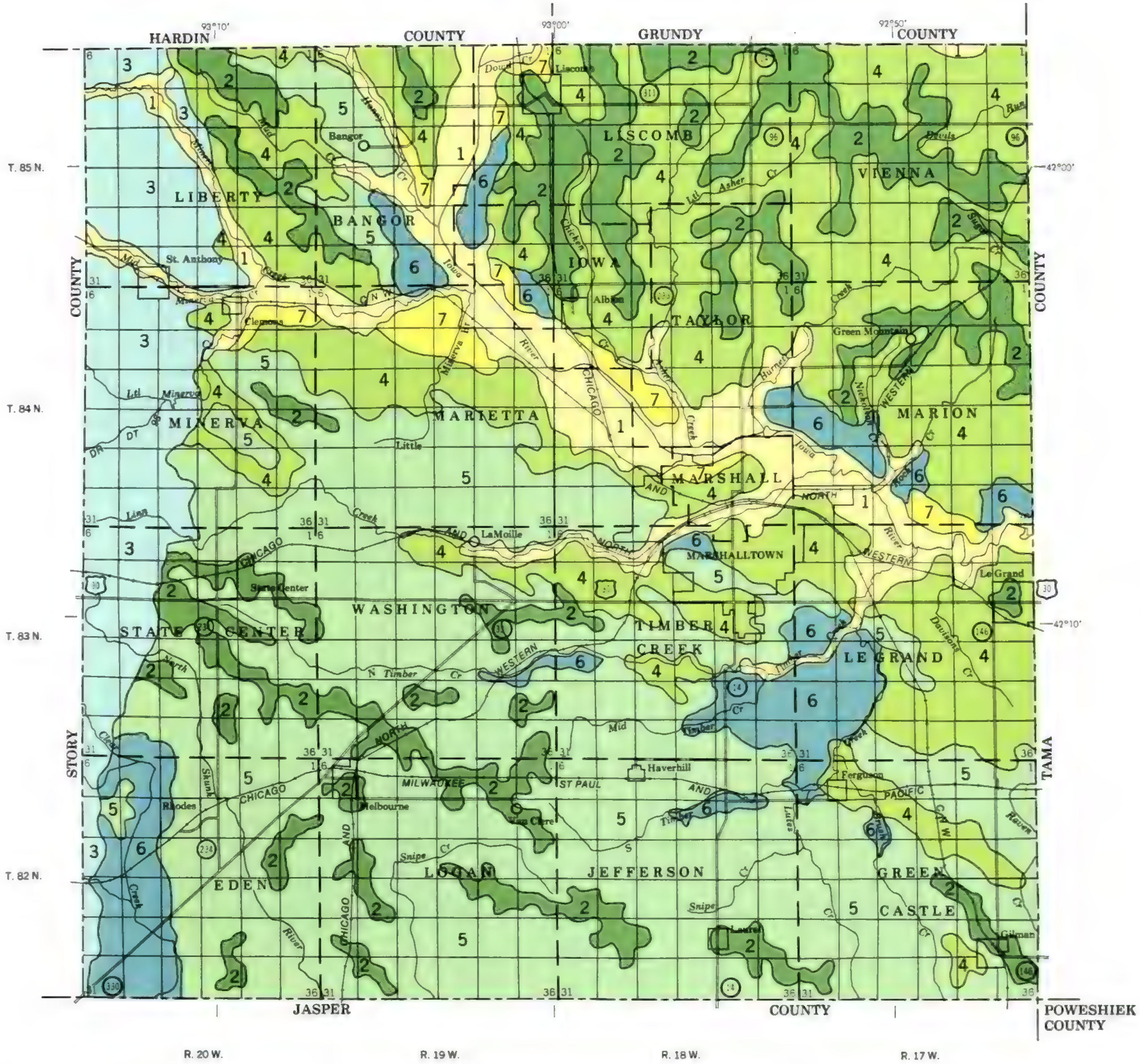
This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
IOWA AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION
COOPERATIVE EXTENSION SERVICE, IOWA STATE UNIVERSITY
DEPARTMENT OF SOIL CONSERVATION, STATE OF IOWA

GENERAL SOIL MAP
MARSHALL COUNTY, IOWA

Scale 1:190,080

N



SOIL LEGEND*

1 Colo-Lawson-Zook association: Nearly level, poorly drained and somewhat poorly drained, silty soils formed in alluvium; on bottom lands and alluvial fans

2 Muscatine-Tama-Garwin association: Nearly level and gently sloping, somewhat poorly drained, well drained, and poorly drained, silty soils formed in loess; on uplands

3 Clarion-Nicollet-Webster association: Nearly level to moderately steep, well drained, somewhat poorly drained, and poorly drained, loamy and silty soils formed in glacial till; on uplands

4 Tama association: Moderately sloping and strongly sloping, well drained, silty soils formed in loess; on uplands

5 Killduff-Tama-Shelby association: Moderately sloping to steep, well drained and moderately well drained, silty and loamy soils formed in loess and glacial till; on uplands

6 Downs-Gara association: Gently sloping to steep, well drained and moderately well drained, silty and loamy soils formed in loess and glacial till; on uplands

7 Dickinson-Sparta association: Gently sloping to strongly sloping, well drained to excessively drained, loamy and sandy soils formed in eolian sand and wind-reworked alluvium; on uplands and benches

*The texture terms in the descriptive headings refer to the surface layer of the major soils in each association.

Compiled 1980

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

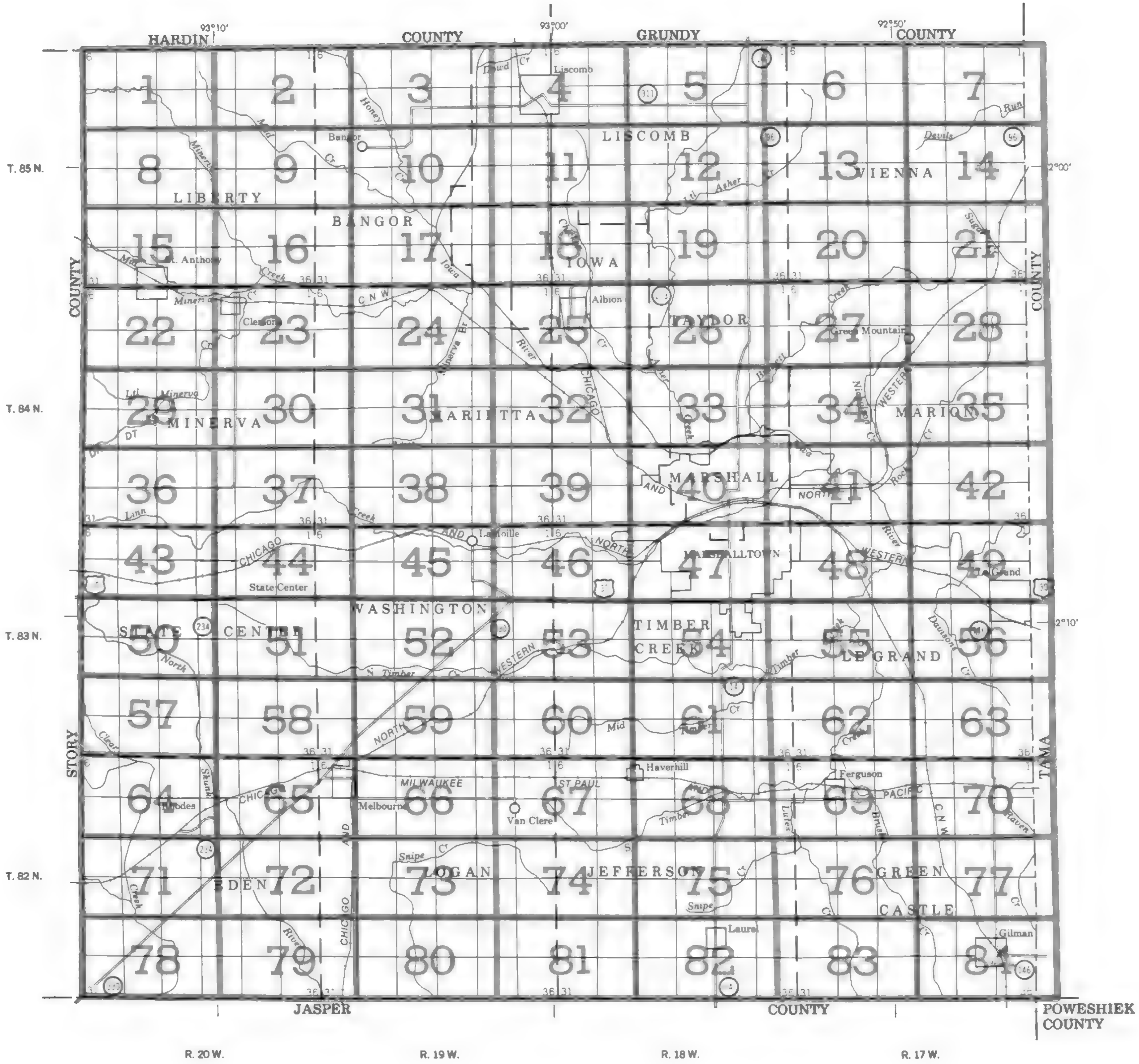
N

INDEX TO MAP SHEETS
MARSHALL COUNTY, IOWA

Scale 1:190,080

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 Kilometers



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and letters The initial numbers represent the kind of soil A capital letter following these numbers indicates the class of slope Symbols without a slope letter are for nearly level soils or miscellaneous areas A final number of 2 following the slope letter indicates that the soil is moderately eroded and 3 that it is severely eroded A plus sign at the end of the symbol indicates an overwashed soil

SYMBOL	NAME	SYMBOL	NAME
5B	Ackmore-Colo complex 2 to 5 percent slopes	163B	Fayette silt loam 2 to 5 percent slopes
6	Okoboji silty clay loam 0 to 1 percent slopes	163C	Fayette silt loam 5 to 9 percent slopes
7	Wiota silty clay loam 1 to 3 percent slopes	163D	Fayette silt loam 9 to 14 percent slopes
8B	Judson silty clay loam 2 to 5 percent slopes	163E	Fayette silt loam 14 to 18 percent slopes
8C	Judson silty clay loam 5 to 9 percent slopes	163F	Fayette silt loam 18 to 25 percent slopes
11B	Colo-Ely complex 2 to 5 percent slopes	175B	Dickinson fine sandy loam 2 to 5 percent slopes
20C2	Killduff silty clay loam 5 to 9 percent slopes moderately eroded	175C	Dickinson fine sandy loam 5 to 9 percent slopes
20D2	Killduff silty clay loam 9 to 14 percent slopes moderately eroded	175D2	Dickinson fine sandy loam 9 to 14 percent slopes moderately eroded
20D3	Killduff silty clay loam 9 to 14 percent slopes severely eroded	177	Saude loam 1 to 3 percent slopes
20E2	Killduff silty clay loam 14 to 18 percent slopes moderately eroded	177C2	Saude loam 5 to 9 percent slopes moderately eroded
20E3	Killduff silty clay loam 14 to 18 percent slopes severely eroded	178	Waukee loam 1 to 3 percent slopes
24D2	Shelby loam 9 to 14 percent slopes moderately eroded	179E	Gara loam 14 to 18 percent slopes
24D3	Shelby clay loam 9 to 14 percent slopes severely eroded	179E2	Gara loam 14 to 18 percent slopes moderately eroded
24E2	Shelby loam 14 to 18 percent slopes moderately eroded	179F	Gara loam 18 to 25 percent slopes
24E3	Shelby clay loam 14 to 18 percent slopes severely eroded	192D2	Adair clay loam 9 to 14 percent slopes moderately eroded
24F2	Shelby loam 18 to 25 percent slopes moderately eroded	201B	Coland Terril complex 2 to 5 percent slopes
41B	Sparta loamy fine sand 2 to 5 percent slopes	220	Nodaway silt loam 0 to 2 percent slopes
41C	Sparta loamy fine sand 5 to 9 percent slopes	222D2	Clarinda silty clay loam 9 to 14 percent slopes moderately eroded
41D	Sparta loamy fine sand 9 to 14 percent slopes	226	Lawler loam 32 to 40 inches to sand and gravel 0 to 2 percent slopes
43	Bremer silty clay loam 0 to 2 percent slopes	236C	Lester loam 5 to 9 percent slopes
51	Vesser silt loam 0 to 2 percent slopes	236C2	Lester loam 5 to 9 percent slopes moderately eroded
54	Zook silty clay loam 0 to 2 percent slopes	236D2	Lester loam 9 to 14 percent slopes moderately eroded
55	Nicollet loam 1 to 3 percent slopes	236E	Lester loam 14 to 18 percent slopes
62D2	Storden loam 9 to 14 percent slopes moderately eroded	236F	Lester loam 18 to 25 percent slopes
63C	Chelsea loamy fine sand 5 to 9 percent slopes	323C	Terril loam sandy substratum 5 to 9 percent slopes
63E	Chelsea loamy fine sand 9 to 18 percent slopes	377C	Dinsdale silty clay loam 5 to 9 percent slopes
65F	Lindley loam 18 to 25 percent slopes	377C2	Dinsdale silty clay loam 5 to 9 percent slopes moderately eroded
65G	Lindley loam 25 to 40 percent slopes	377D2	Dinsdale silty clay loam 9 to 14 percent slopes moderately eroded
88	Nevin silty clay loam 1 to 3 percent slopes	420B	Tama silty clay loam benches 2 to 5 percent slopes
93D2	Shelby Adair complex 9 to 14 percent slopes moderately eroded	420C2	Tama silty clay loam benches 5 to 9 percent slopes moderately eroded
93E2	Shelby-Adair complex 14 to 18 percent slopes moderately eroded	428B	Ely silty clay loam 2 to 5 percent slopes
95	Harps loam 0 to 2 percent slopes	430	Ackmore silt loam 0 to 2 percent slopes
107	Webster silty clay loam 0 to 2 percent slopes	442B	Dickinson-Sparta-Tama complex 2 to 5 percent slopes
118	Garwin silty clay loam 0 to 2 percent slopes	442C2	Dickinson Sparta-Tama complex 5 to 12 percent slopes moderately eroded
119	Muscatine silty clay loam 1 to 3 percent slopes	442E2	Dickinson Sparta Tama complex 12 to 18 percent slopes moderately eroded
120	Tama silty clay loam 0 to 2 percent slopes	462B	Downs silt loam benches 2 to 5 percent slopes
120B	Tama silty clay loam 2 to 5 percent slopes	484	Lawson silty clay loam 0 to 2 percent slopes
120C	Tama silty clay loam 5 to 9 percent slopes	485	Spillville loam 0 to 2 percent slopes
120C2	Tama silty clay loam 5 to 9 percent slopes moderately eroded	507	Canisteo silty clay loam 0 to 2 percent slopes
120D2	Tama silty clay loam 9 to 14 percent slopes moderately eroded	536	Hanlon fine sandy loam 0 to 2 percent slopes
120E2	Tama silty clay loam 14 to 18 percent slopes moderately eroded	595	Harpster silty clay loam 0 to 2 percent slopes
122	Sperry silt loam 0 to 2 percent slopes	683C2	Liscomb loam 5 to 9 percent slopes moderately eroded
133	Colo silty clay loam 0 to 2 percent slopes	683D	Liscomb loam 9 to 14 percent slopes
133+	Colo silt loam 0 to 2 percent slopes	683D2	Liscomb loam 9 to 14 percent slopes moderately eroded
133B	Colo silty clay loam 2 to 5 percent slopes	683E	Liscomb loam, 14 to 18 percent slopes
135	Coland silty clay loam 0 to 2 percent slopes	683E2	Liscomb loam 14 to 18 percent slopes moderately eroded
138B	Clarion loam 2 to 5 percent slopes	688	Koszta silt loam 1 to 3 percent slopes
138C	Clarion loam 5 to 9 percent slopes	1133	Colo silty clay loam channeled 0 to 2 percent slopes
138C2	Clarion loam 5 to 9 percent slopes moderately eroded	1220	Nodaway silt loam channeled 0 to 2 percent slopes
138D2	Clarion loam 9 to 14 percent slopes moderately eroded	1485	Spillville loam channeled 0 to 2 percent slopes
138E2	Clarion loam 14 to 18 percent slopes moderately eroded	1936	Colo-Hanlon-Lawson complex channeled 0 to 2 percent slopes
150	Hanska loam 0 to 2 percent slopes	4011B	Colo-Ely-Urban land complex 2 to 5 percent slopes
162B	Downs silt loam 2 to 5 percent slopes	4119	Muscatine-Urban land complex 1 to 3 percent slopes
162C	Downs silt loam 5 to 9 percent slopes	4120B	Tama-Urban land complex 2 to 5 percent slopes
162C2	Downs silt loam 5 to 9 percent slopes moderately eroded	4120C	Tama Urban land complex 5 to 9 percent slopes
162D	Downs silt loam 9 to 14 percent slopes	4133	Colo Urban land complex 0 to 2 percent slopes
162D2	Downs silt loam 9 to 14 percent slopes moderately eroded	5010	Pits sand and gravel
162E2	Downs silt loam 14 to 18 percent slopes moderately eroded	5030	Pits limestone quarry

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate
- Federal
- State
- County, farm or ranch

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — GAS
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
- Drainage end
- Canals or ditches
  - Double-line (label)
  - Drainage and/or irrigation

LAKES PONDS AND RESERVOIRS

- Perennial
- Intermittent

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — 162C2 120B

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

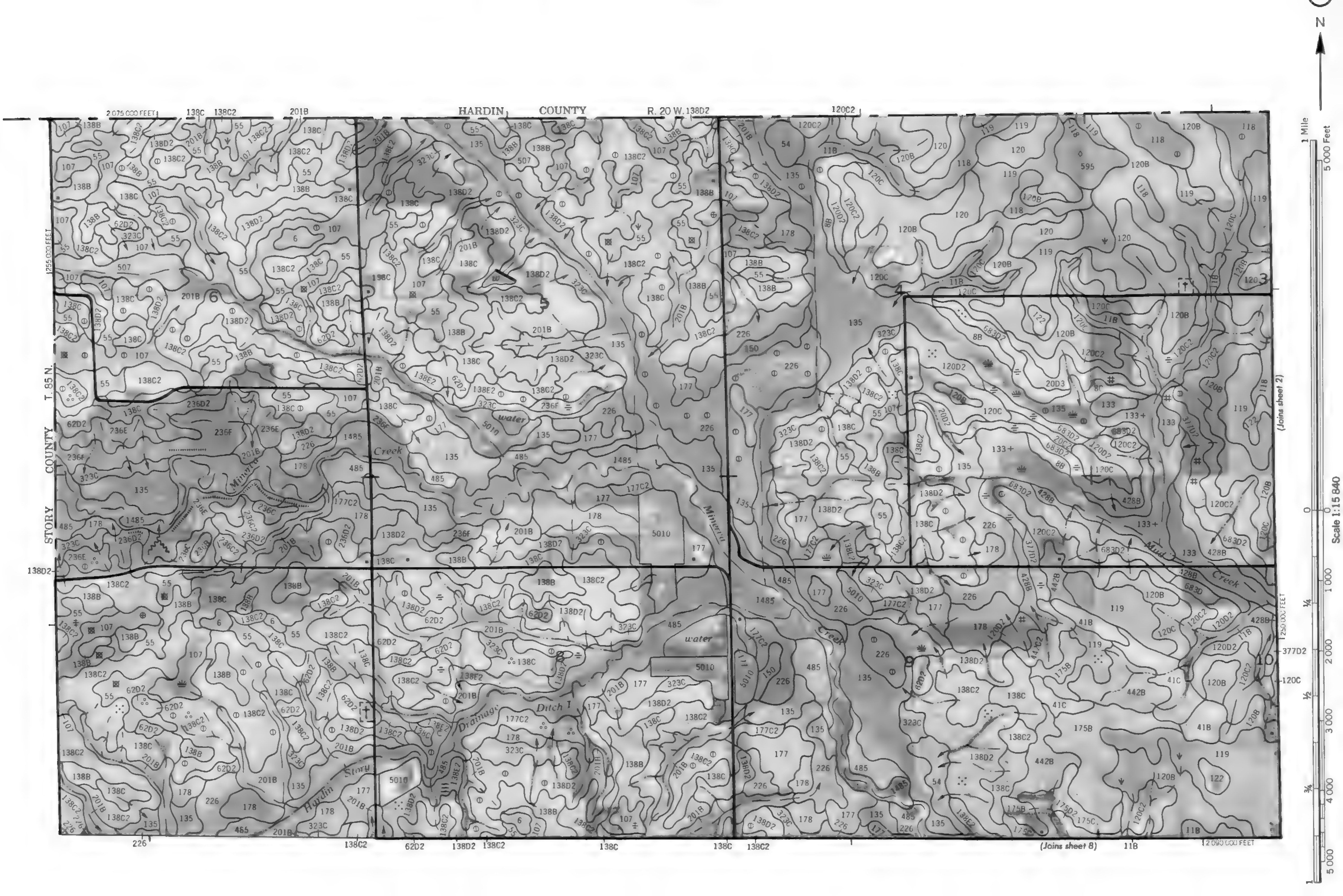
DEPRESSION OR SINK

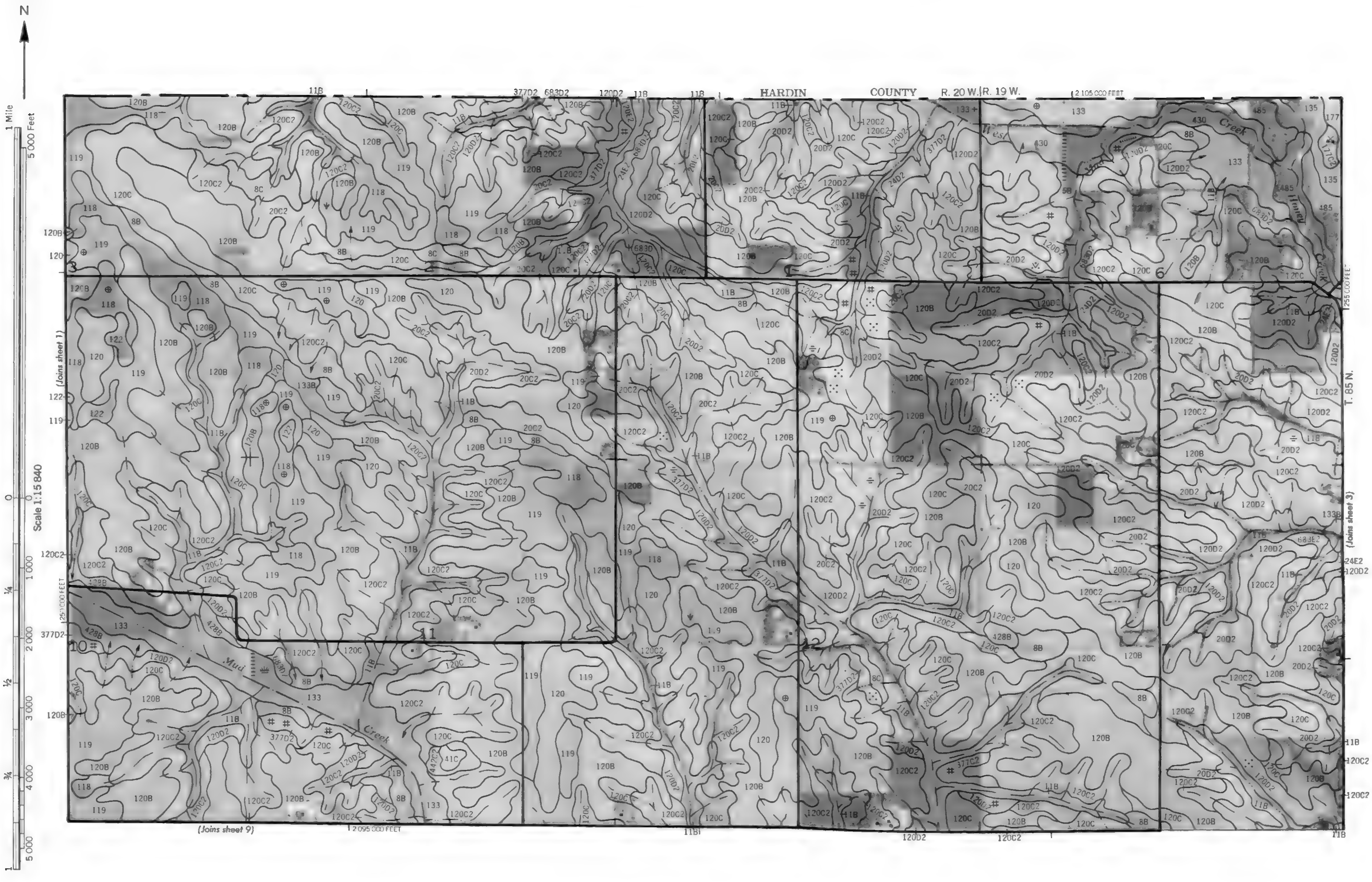
SOIL SAMPLE SITE (normally not shown)

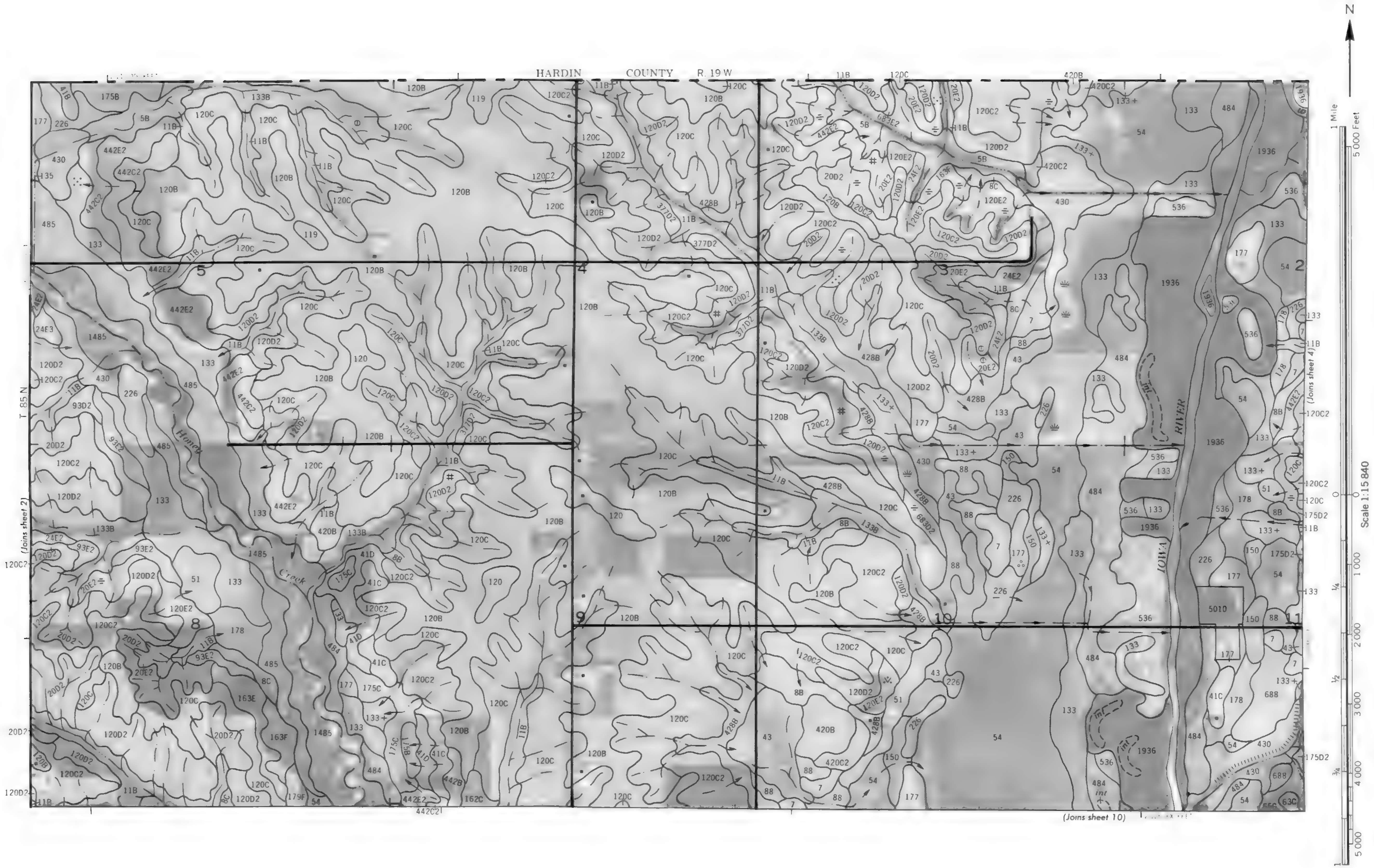
MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Gray clay spot
- Spot of Okoboji soil
- Calcareous spot
- Planosolic spot
- Hump of better drained soil
- Red clay spot
- Glacial till outcrop
- Sewage lagoon — S L

MARSHALL COUNTY, IOWA — SHEET NUMBER 1

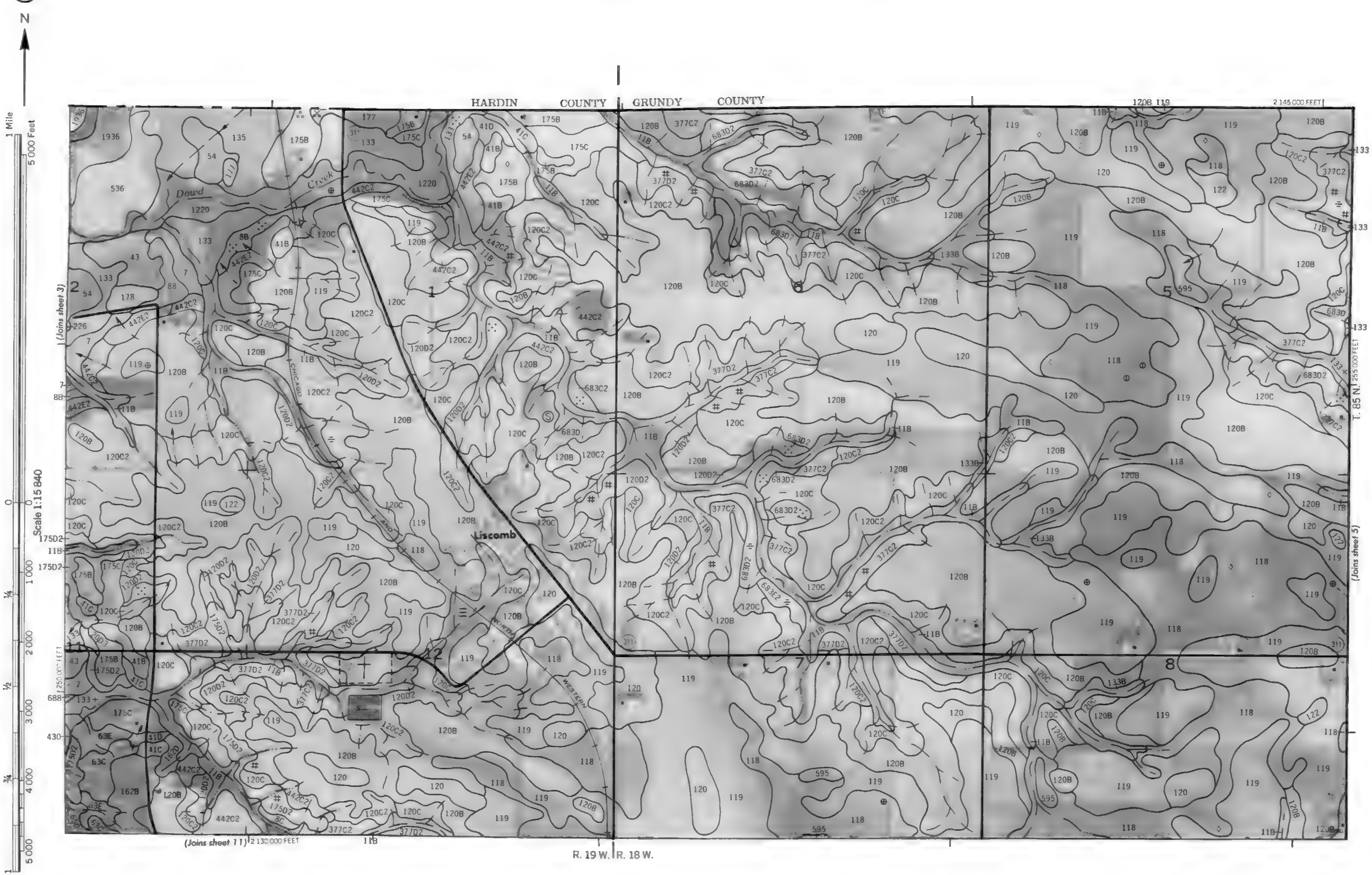


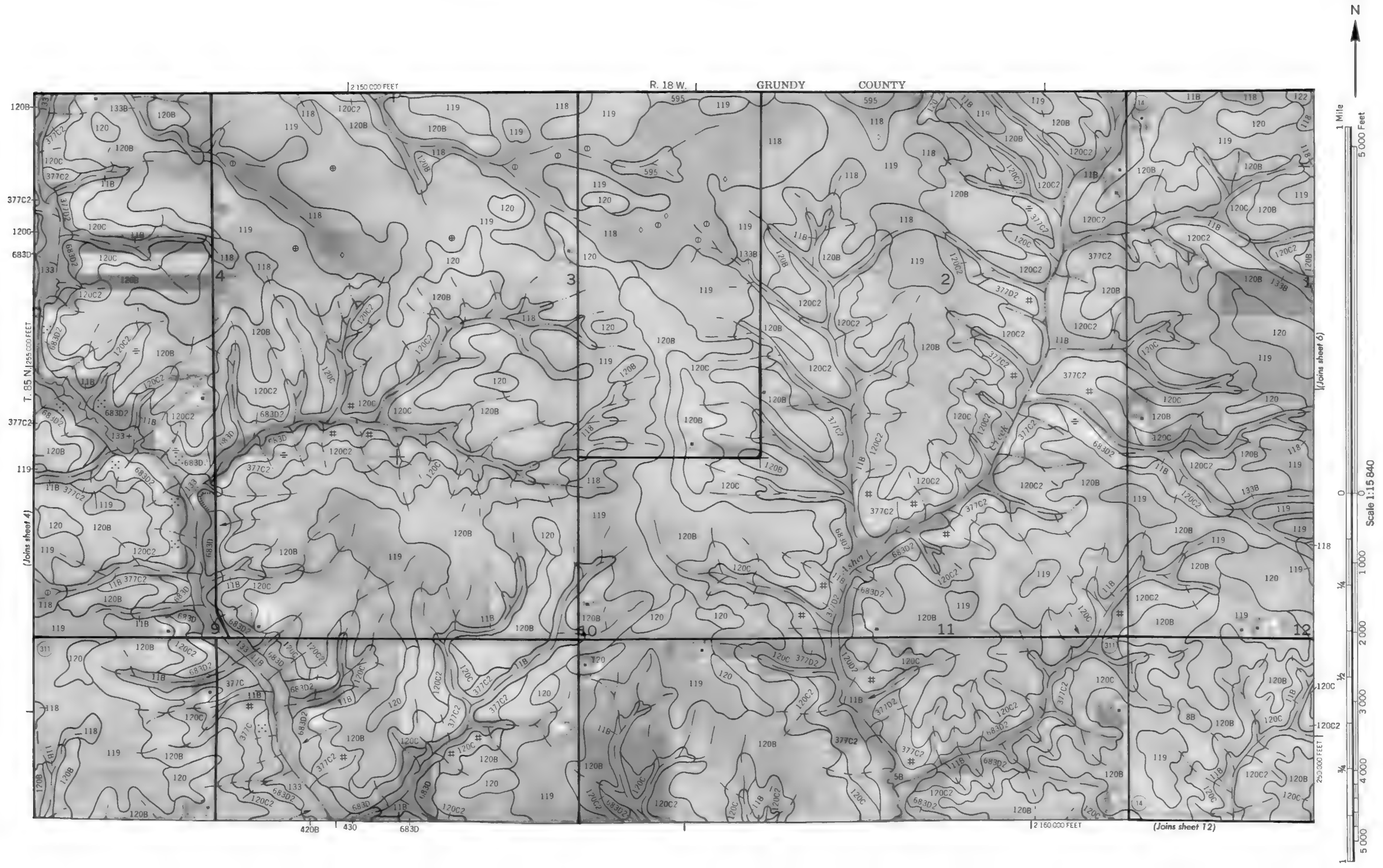

N
1 Mile
5 000 Feet
Scale 1:15 840
HARDIN COUNTY
R. 20 W.
R. 19 W.
T. 85 N.
(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 9)
2 105 000 FEET
2 095 000 FEET
Mud Creek
West Creek


N
HARDIN COUNTY
R. 19 W
T. 85 N
(Joins sheet 2)
(Joins sheet 4)
(Joins sheet 10)
IOWA RIVER
Honey Creek
Scale 1:15 840
1 Mile
5 000 Feet

4

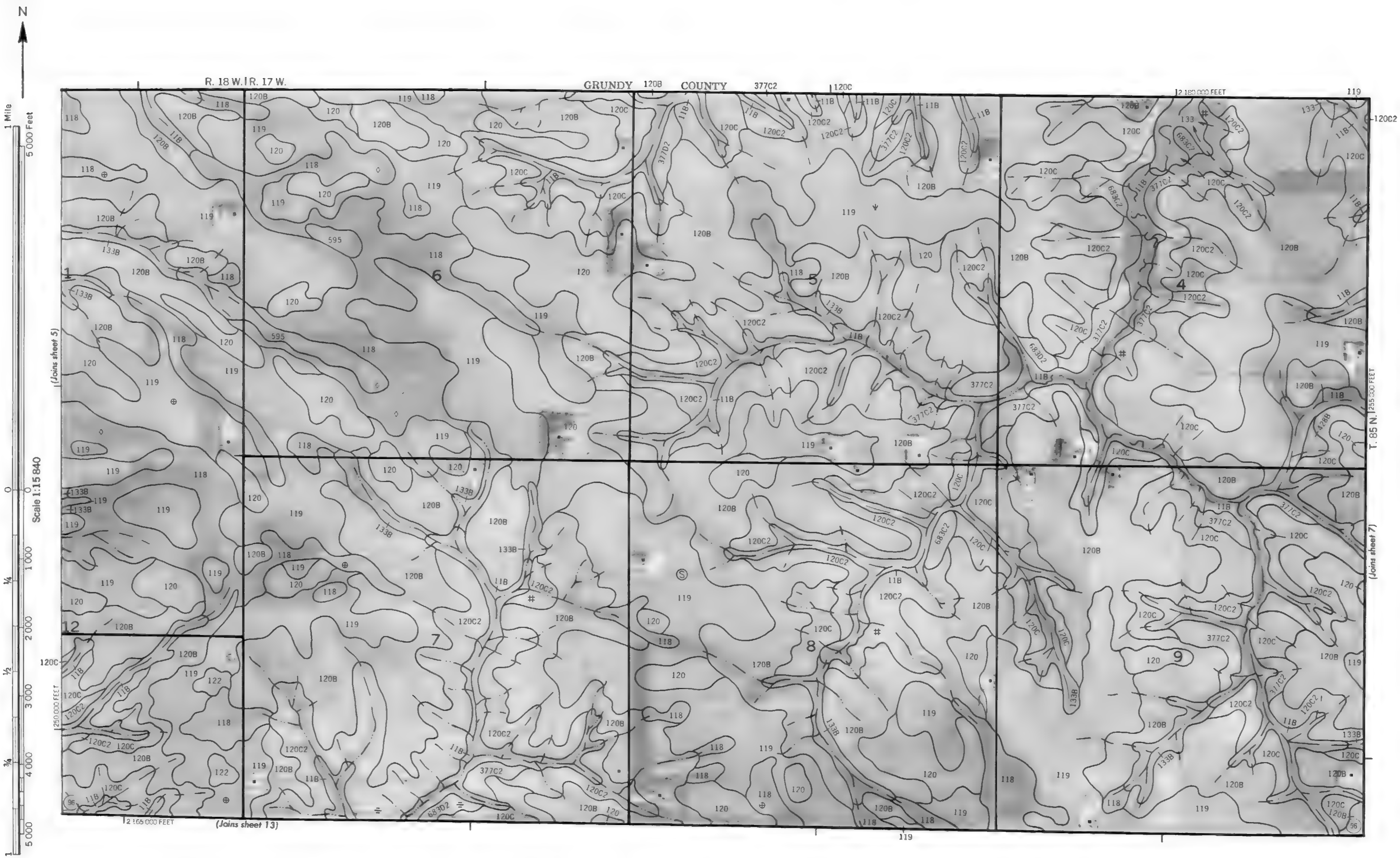
MARSHALL COUNTY, IOWA — SHEET NUMBER 4



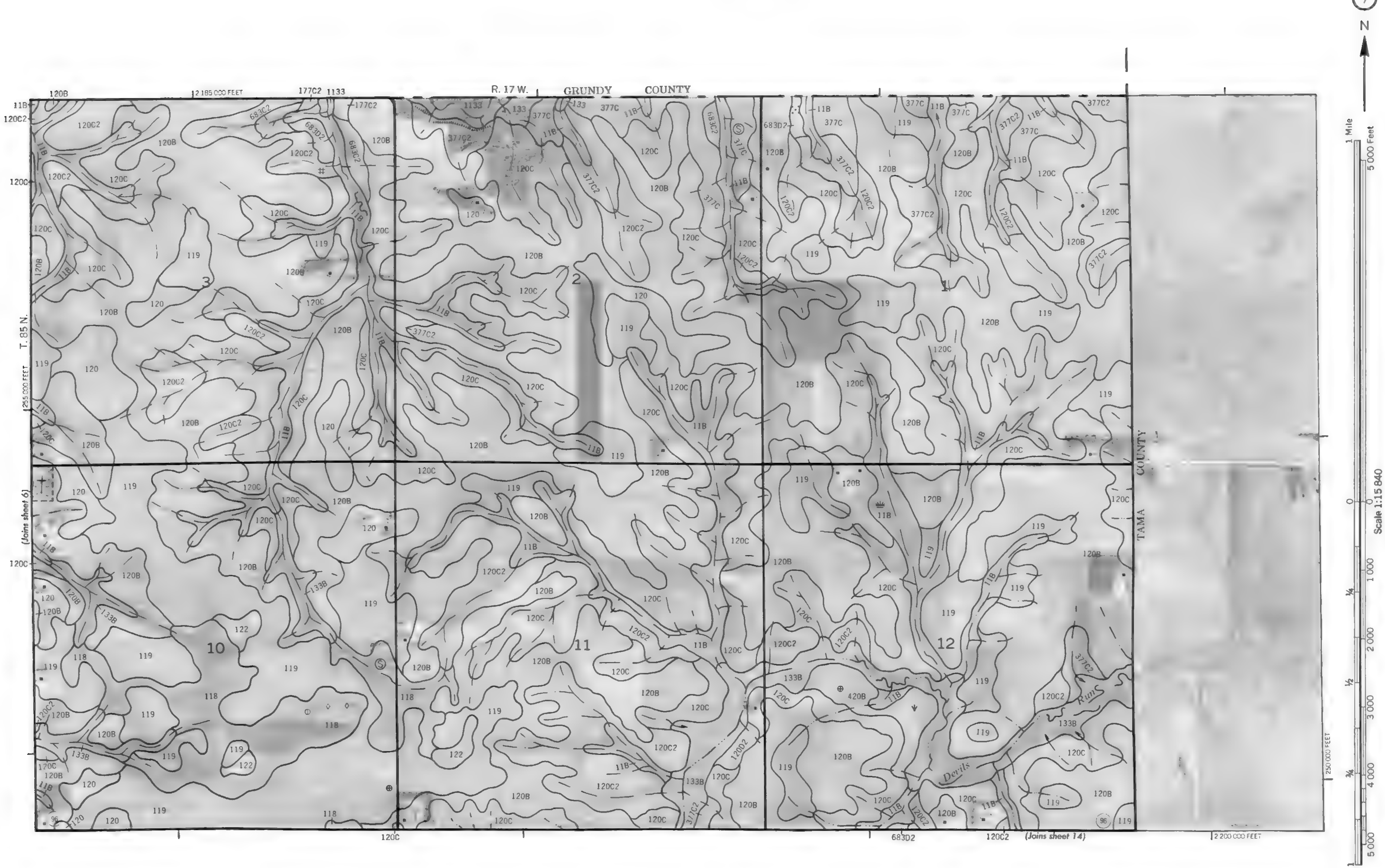

N
R. 18 W.
GRUNDY COUNTY
2 150 000 FEET
2 160 000 FEET
T. 85 N.
255 000 FEET
250 000 FEET
(Joins sheet 4)
(Joins sheet 6)
(Joins sheet 12)
Asher Creek
1 Mile
5 000 Feet
Scale 1:15 840

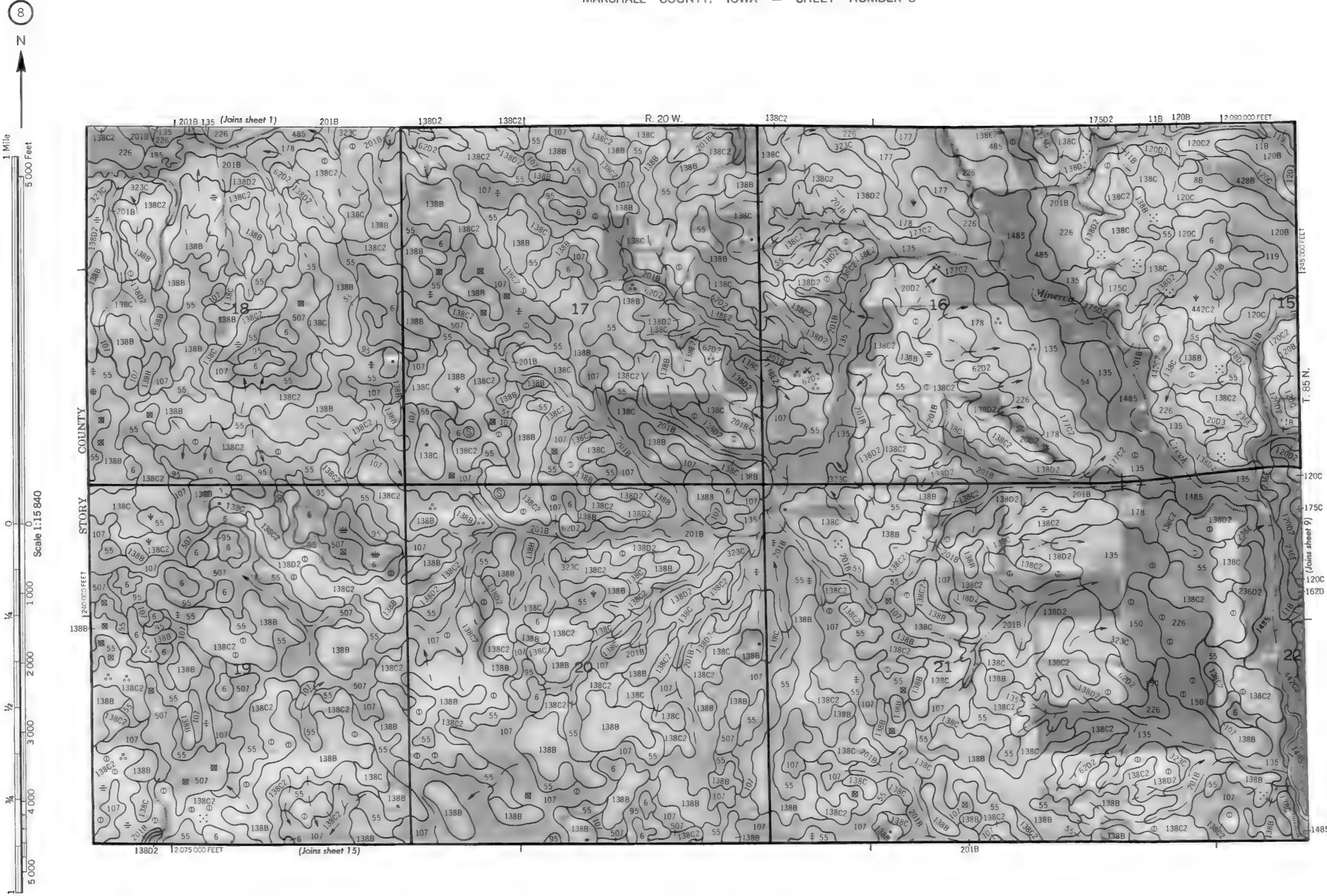
(6)

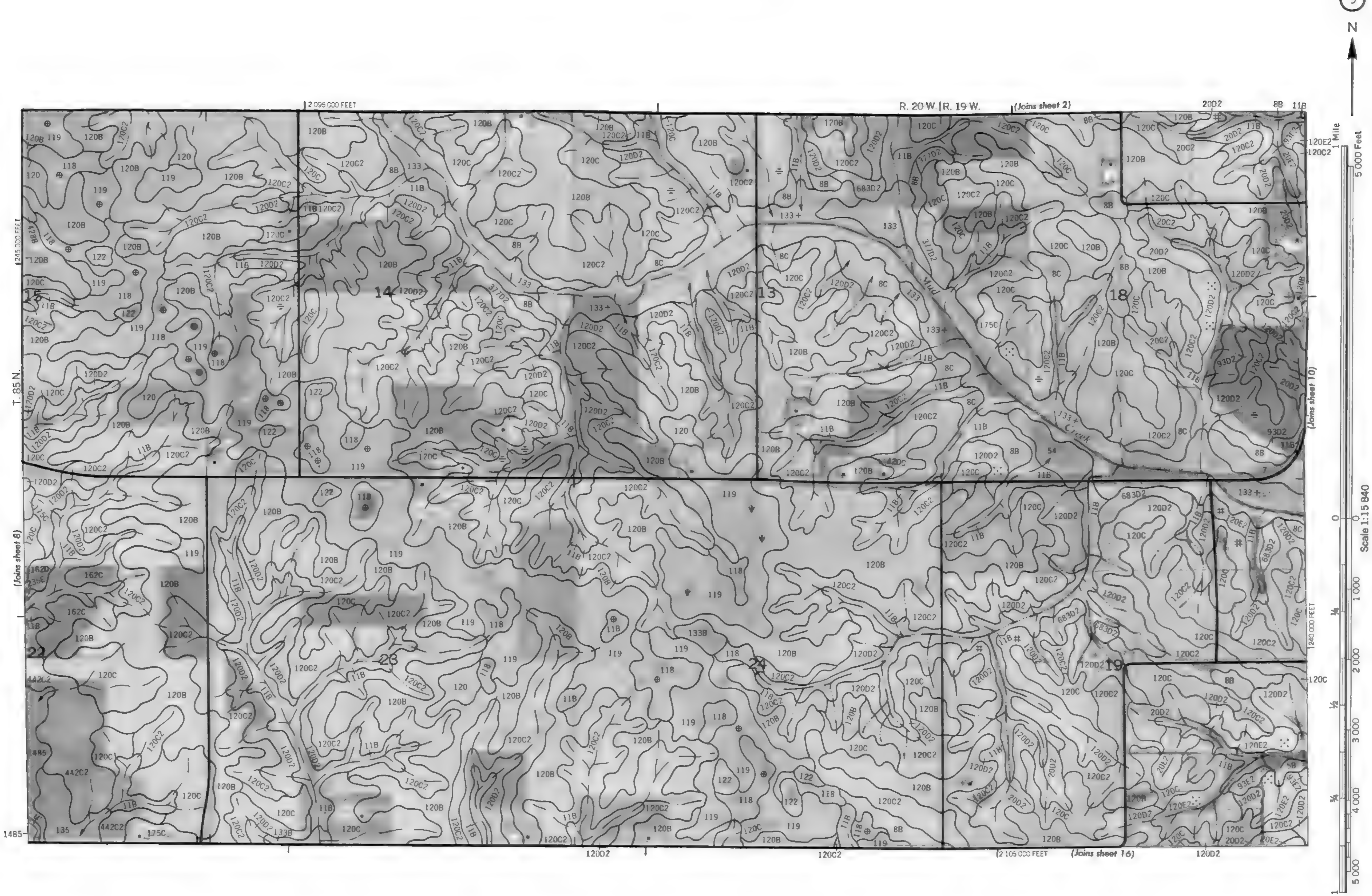
MARSHALL COUNTY, IOWA — SHEET NUMBER 6

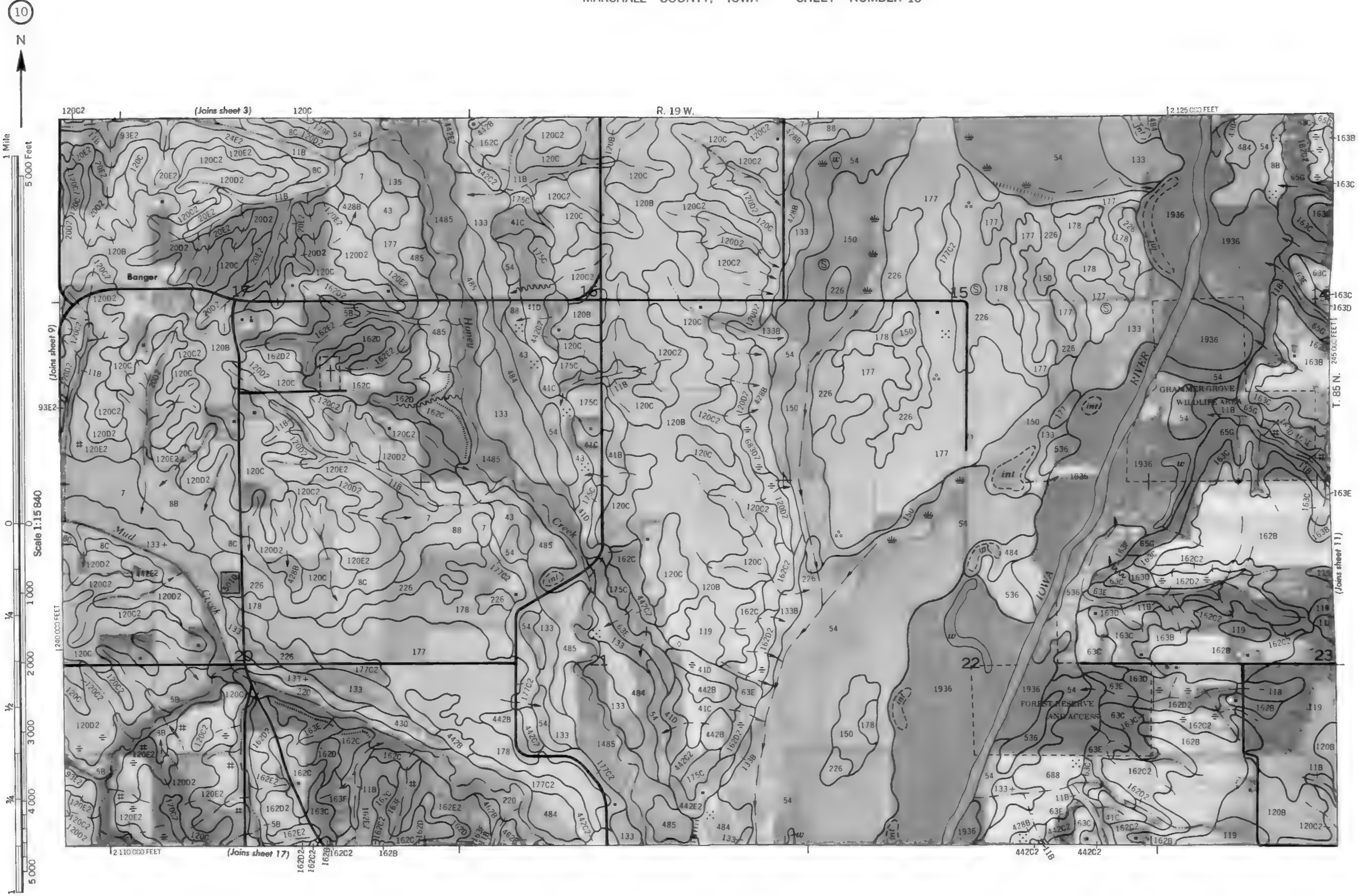


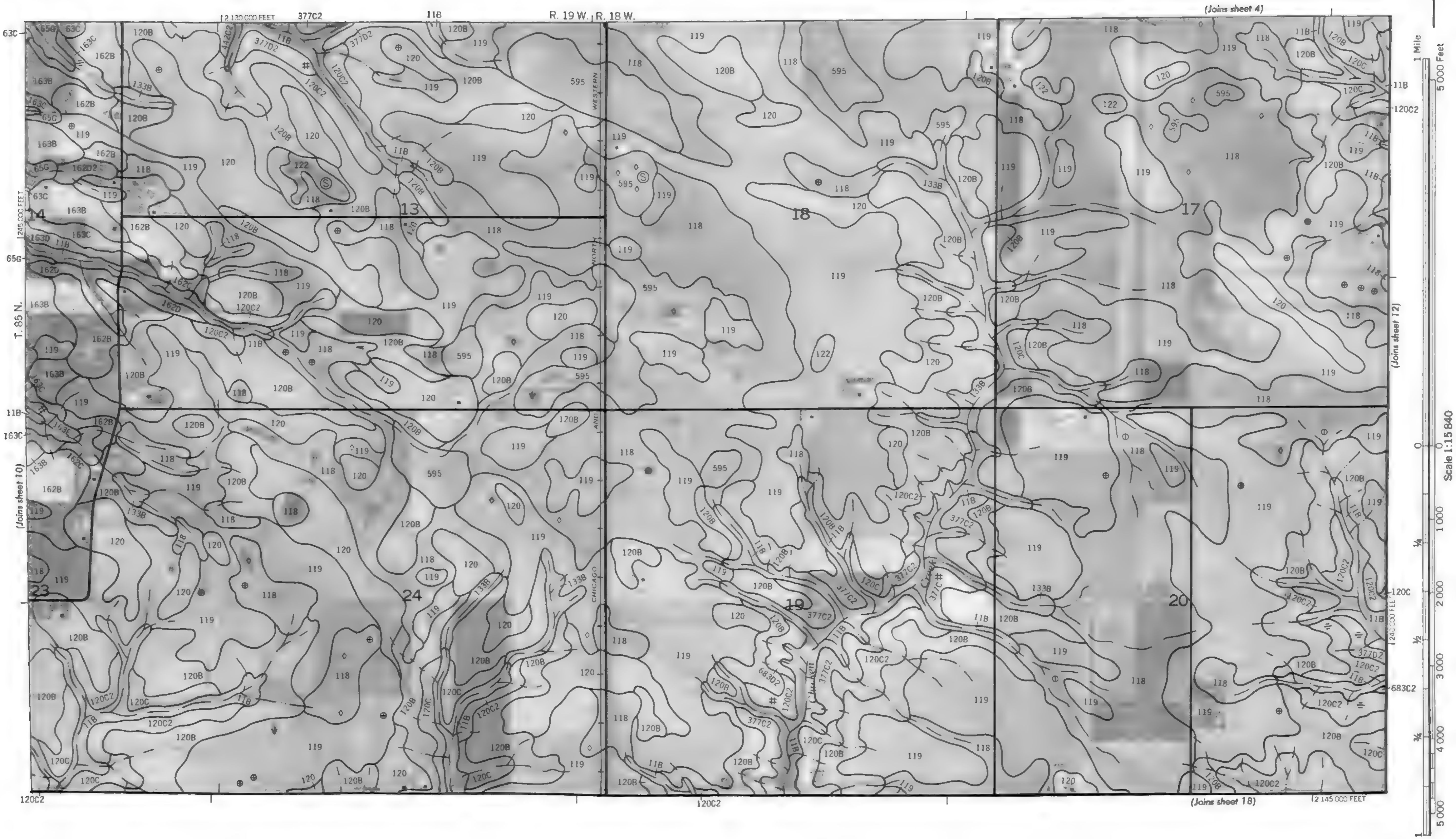
MARSHALL COUNTY, IOWA — SHEET NUMBER 7

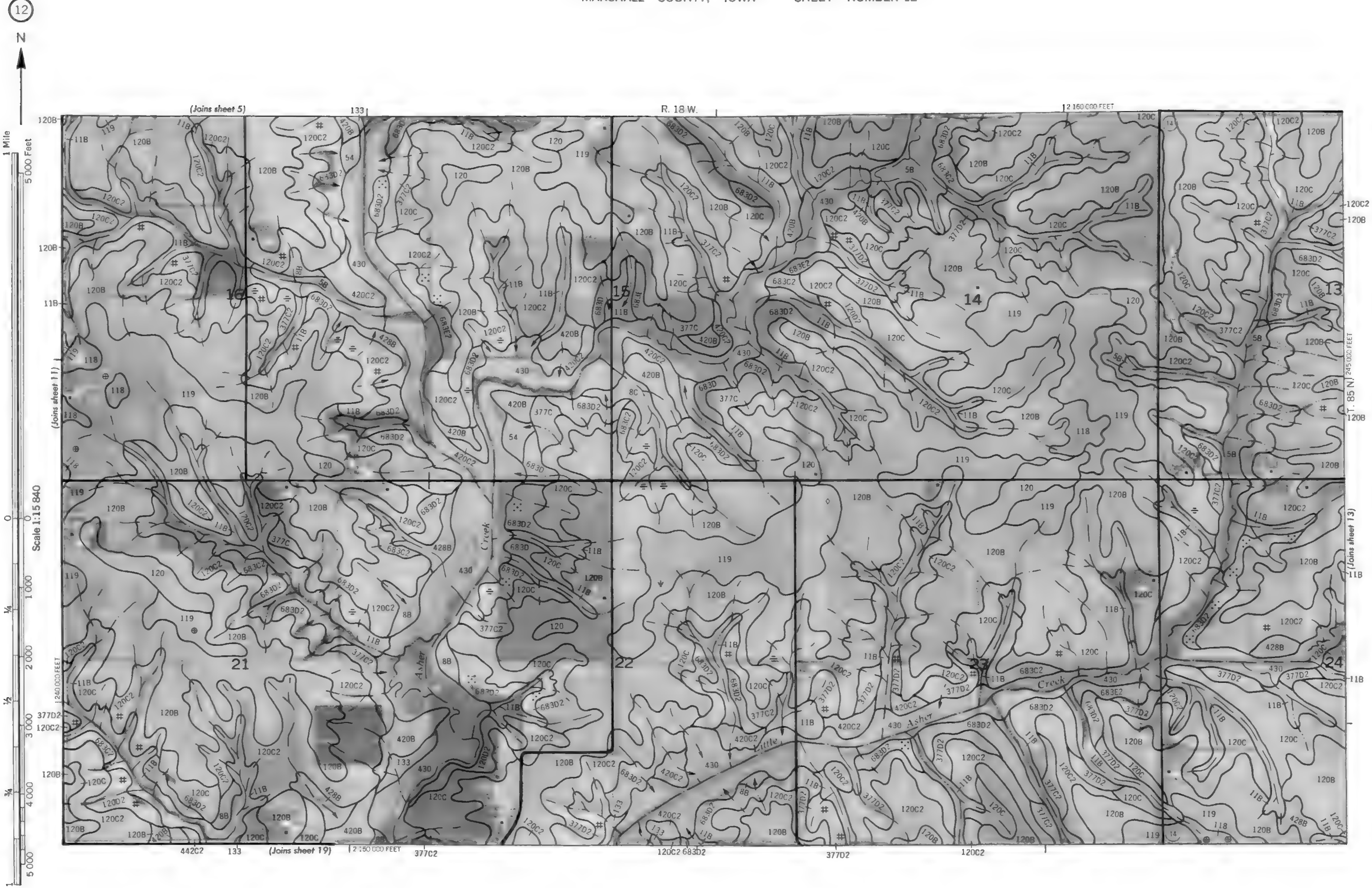


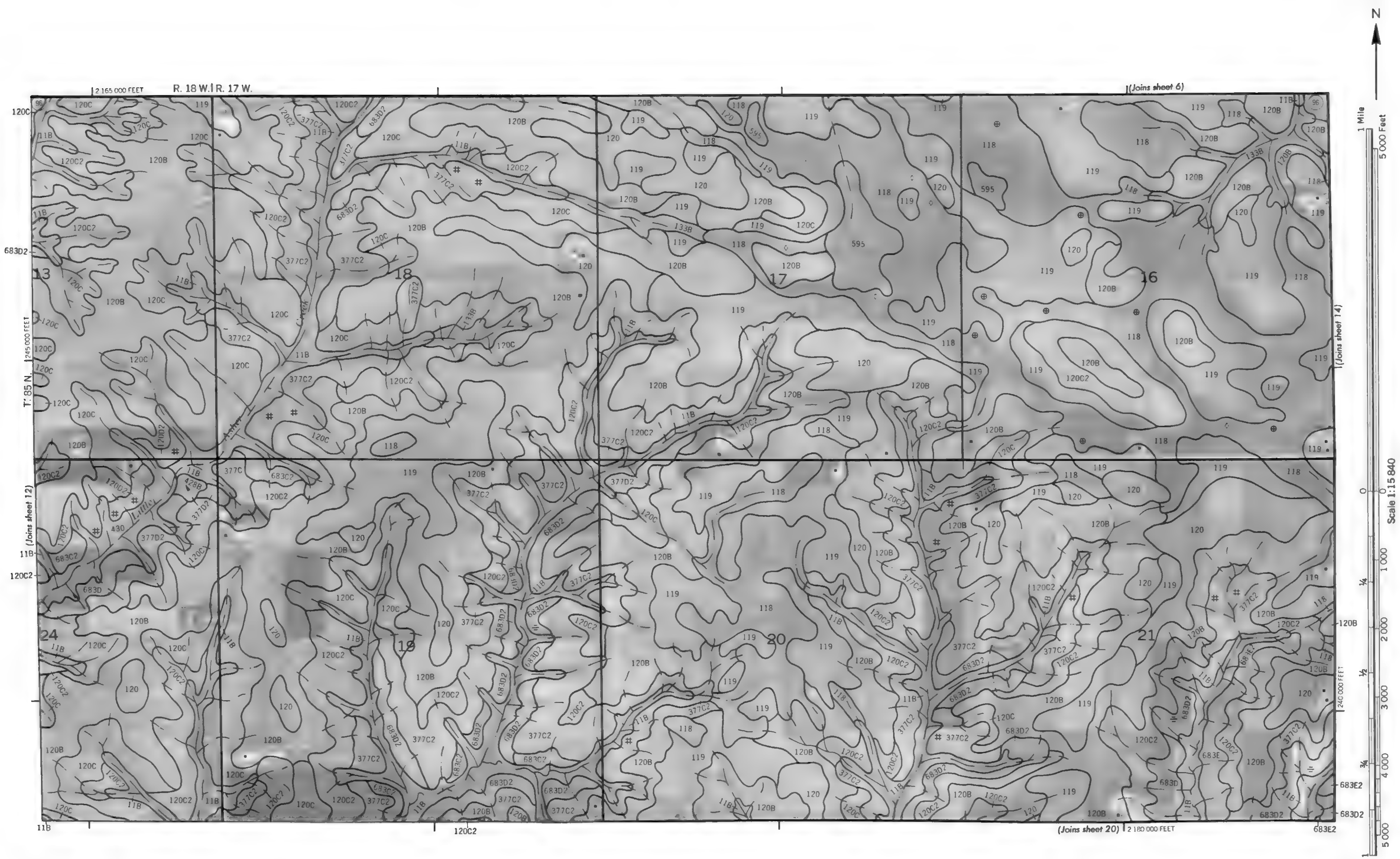

8
N
(Joins sheet 1)
R. 20 W.
2 090 000 FEET
245 000 FEET
T. 85 N.
(Joins sheet 9)
(Joins sheet 15)
2 075 000 FEET
240 000 FEET
STORY COUNTY
Minerva
Creek
18
17
16
15
19
20
21
22
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾
1


9
N
2 095 000 FEET
R. 20 W. | R. 19 W.
(Joins sheet 2)
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 16)
T. 85 N.
245 000 FEET
240 000 FEET
2 105 000 FEET
15
14
13
18
22
23
24
19
Mud
Creek
1 Mile
5 000 Feet
Scale 1:15 840
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000
0

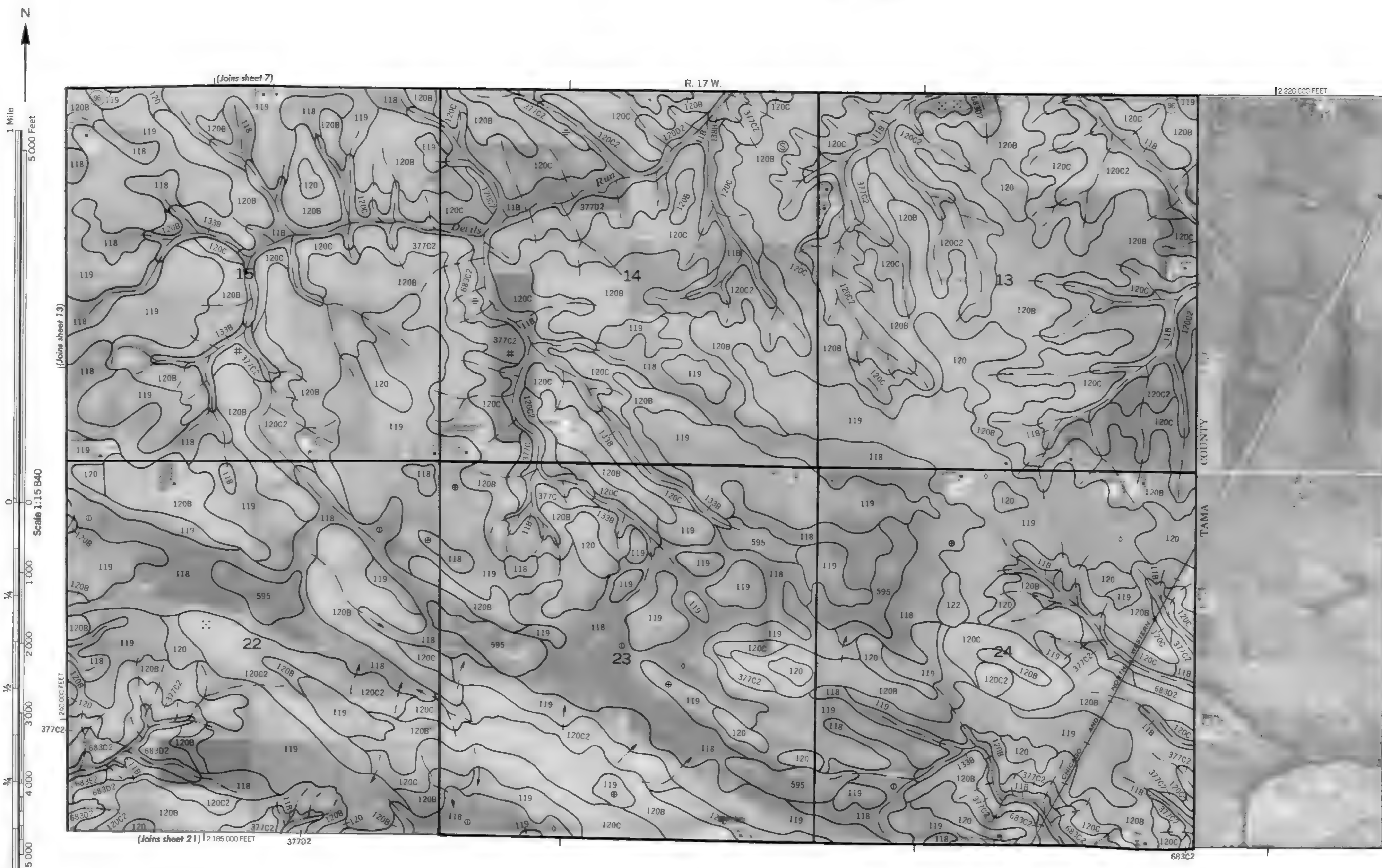

10
N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 3)
R. 19 W.
(Joins sheet 9)
(Joins sheet 11)
(Joins sheet 17)
T. 85 N.
Bangor
Mud Creek
Honey Creek
IOWA RIVER
GRAMMER GROVE WILDLIFE AREA
FOREST RESERVE AND ACCESS
2 125 000 FEET
2 110 000 FEET
240 000 FEET
245 000 FEET

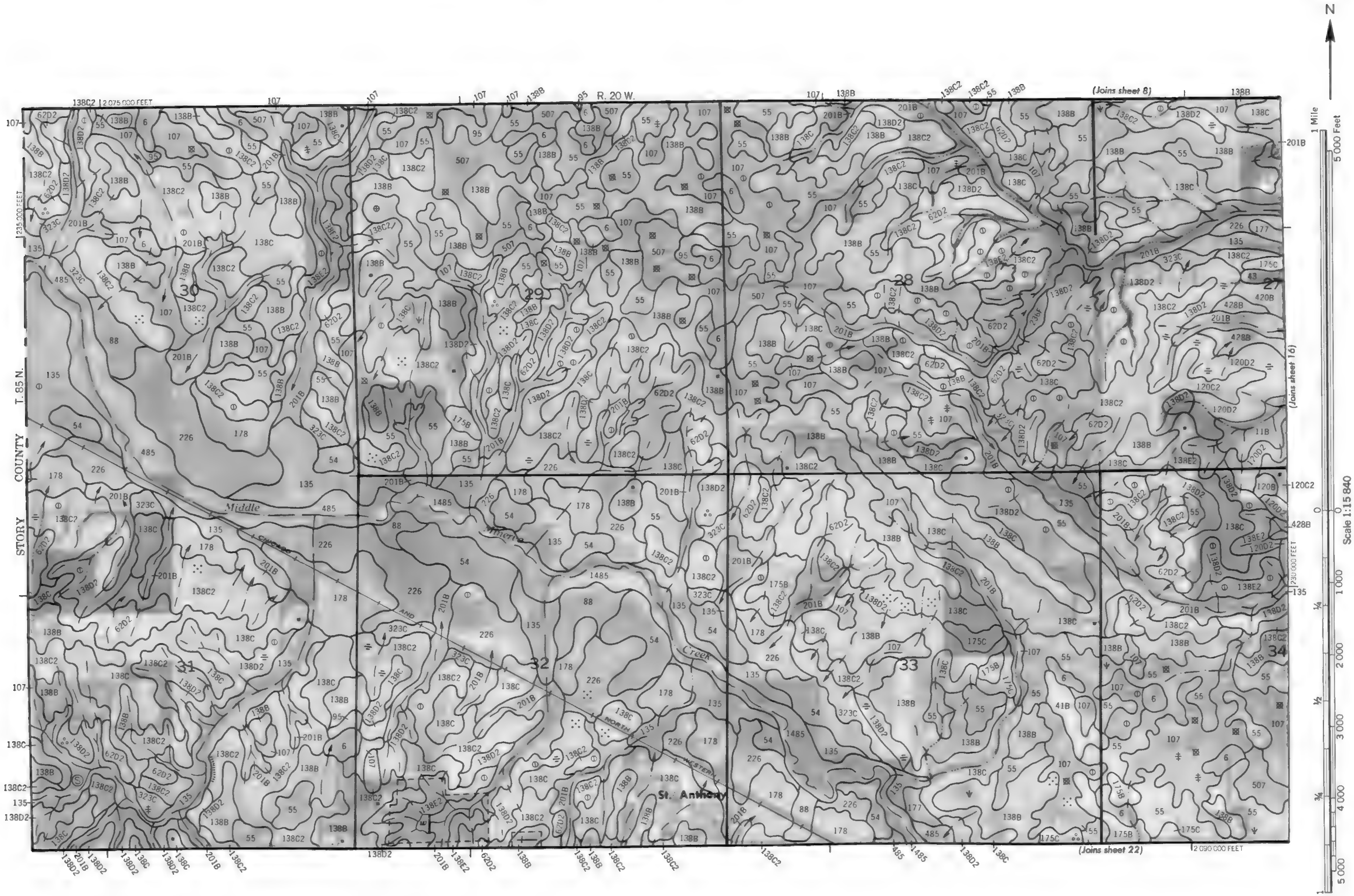

11
N
R. 19 W. R. 18 W.
(Joins sheet 4)
(Joins sheet 12)
(Joins sheet 18)
(Joins sheet 10)
T. 85 N.
2 130 000 FEET
2 145 000 FEET
245 000 FEET
14
13
18
17
23
24
19
20
WESTERN
NORTH
AND
CHICAGO
Creek
Chicken
Scale 1:15 840
1 Mile
5 000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾


12
N
(Joins sheet 5)
R. 18 W.
2 160 000 FEET
(Joins sheet 11)
(Joins sheet 13)
(Joins sheet 19)
T. 85 N.
245 000 FEET
240 000 FEET
2 150 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840
Asher
Creek
Little
16
15
14
13
21
22
23
24

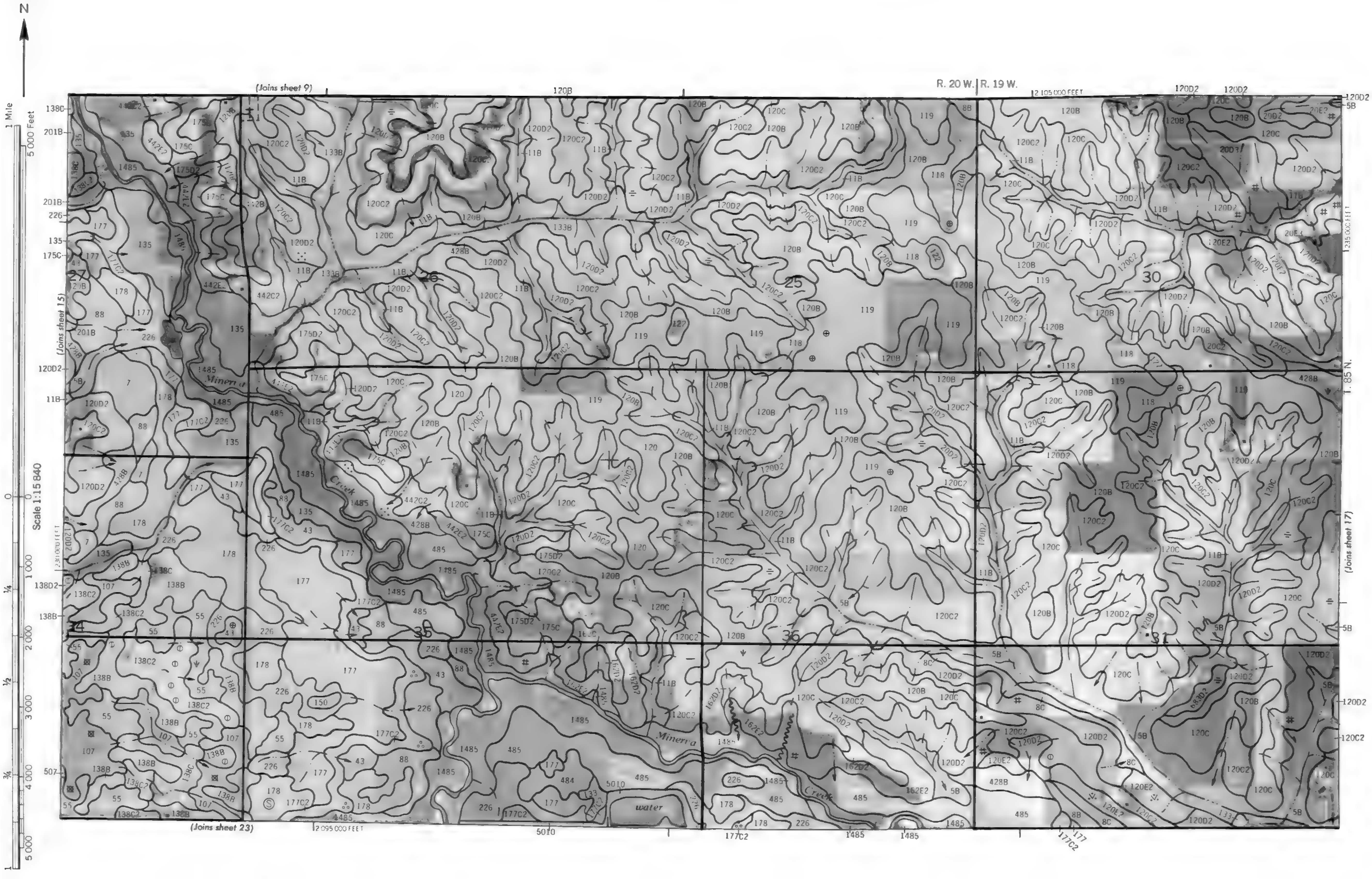

N
2 165 000 FEET
R. 18 W. | R. 17 W.
(Joins sheet 6)
(Joins sheet 14)
(Joins sheet 12)
(Joins sheet 20)
2 180 000 FEET
T. 85 N.
245 000 FEET
240 000 FEET
13
18
17
16
24
19
20
21
Scale 1:15 840
1 Mile
5 000 Feet
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾

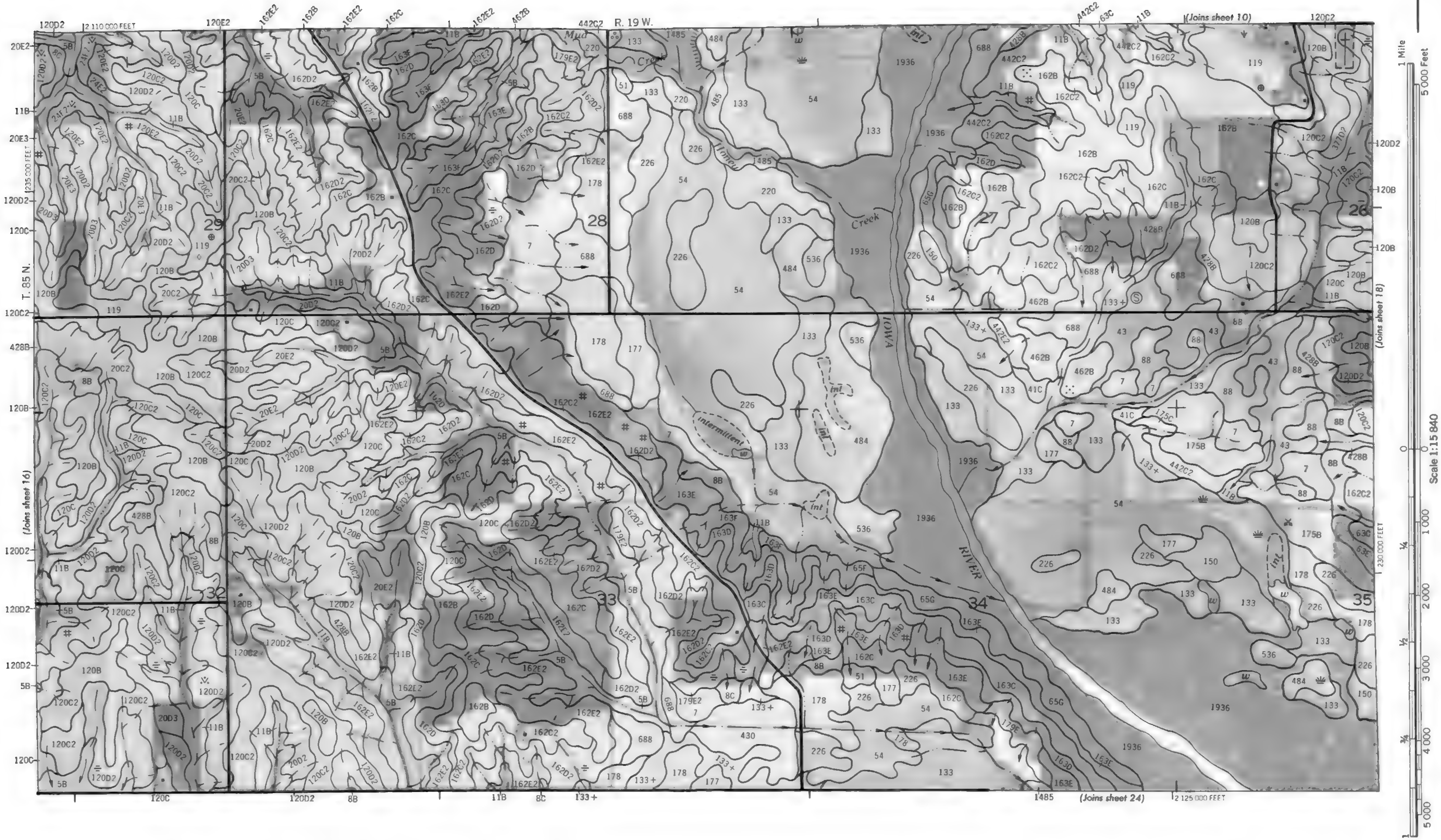
MARSHALL COUNTY, IOWA — SHEET NUMBER 14

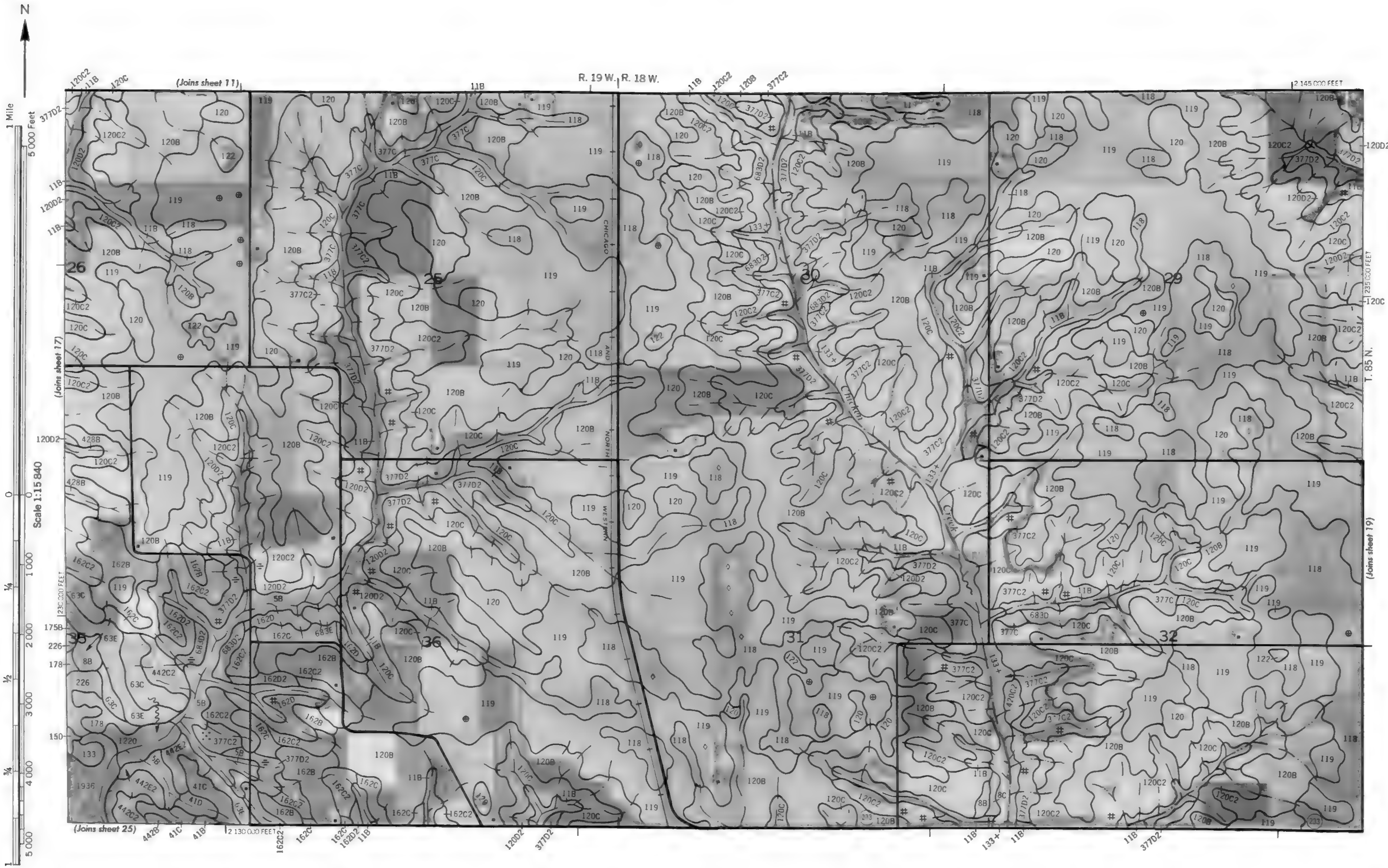


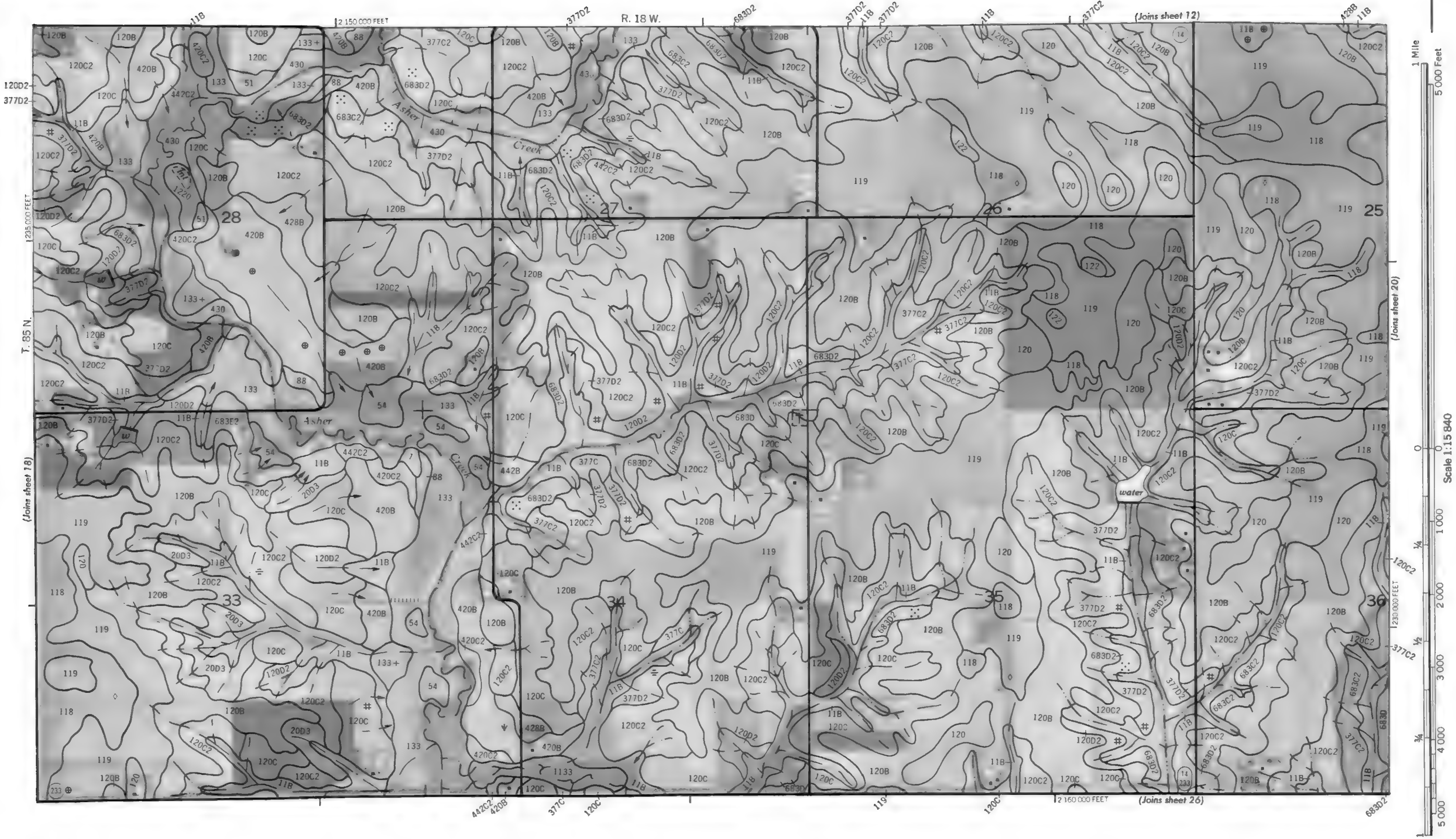

N
R. 20 W.
T. 85 N.
STORY COUNTY
(Joins sheet 8)
(Joins sheet 16)
(Joins sheet 22)
2 075 000 FEET
2 090 000 FEET
235 000 FEET
230 000 FEET
30
29
28
27
31
32
33
34
Middle
Creek
CHICAGO
AND
NORTH
WESTERN
St. Anthony
1 Mile
5 000 Feet
Scale 1:15 840
0
¼
½
¾
1 000
2 000
3 000
4 000
5 000

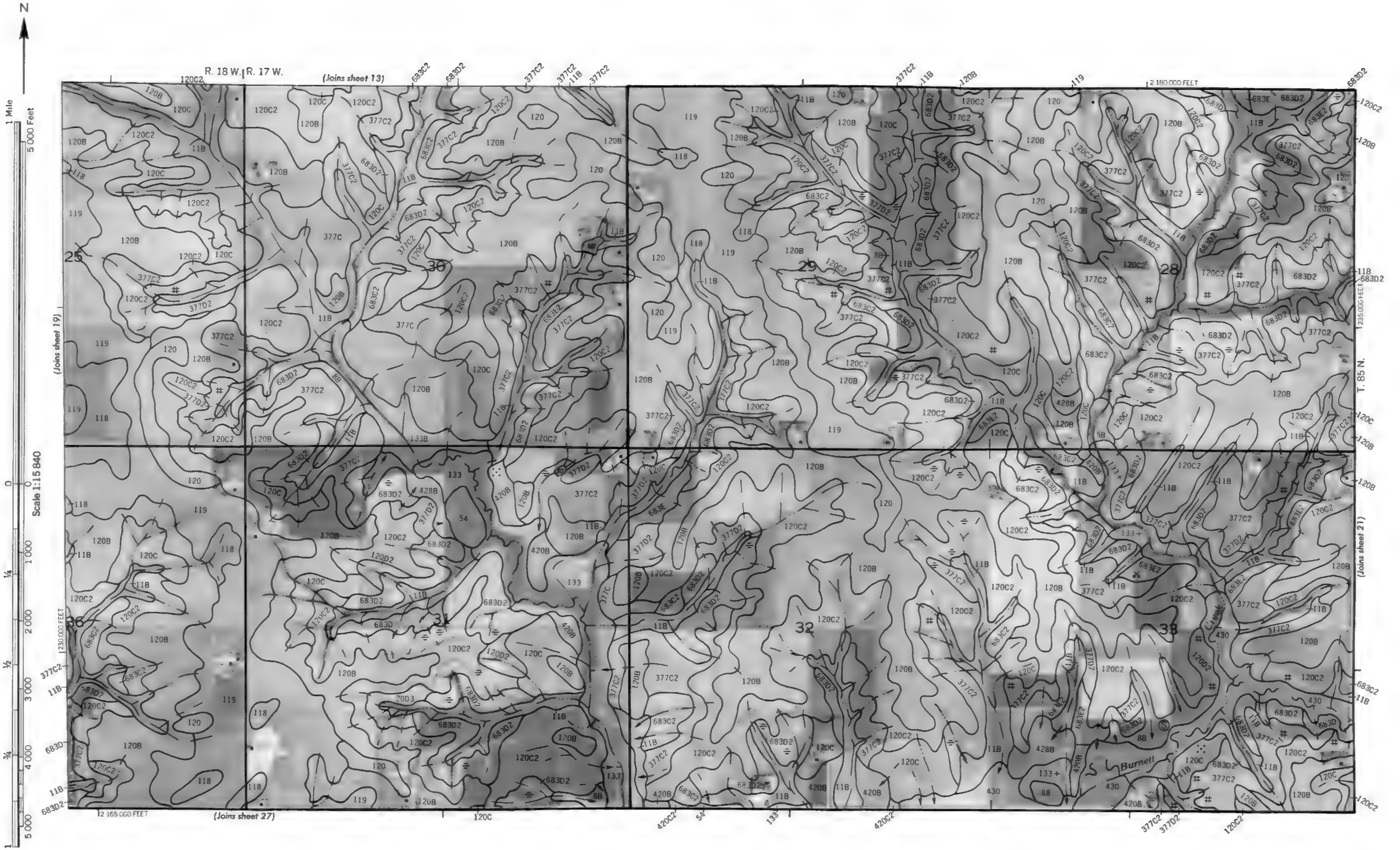
MARSHALL COUNTY, IOWA — SHEET NUMBER 16

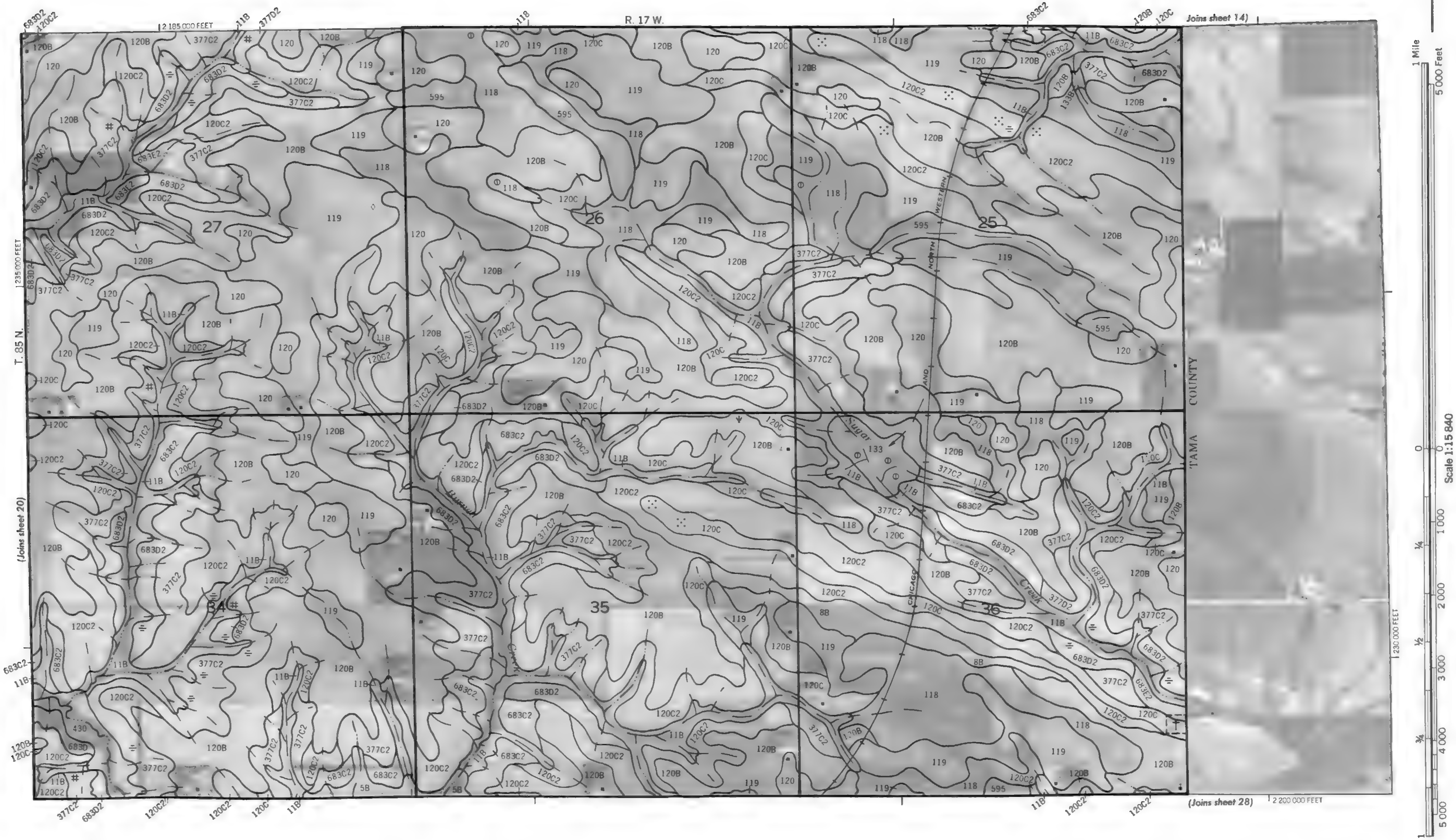


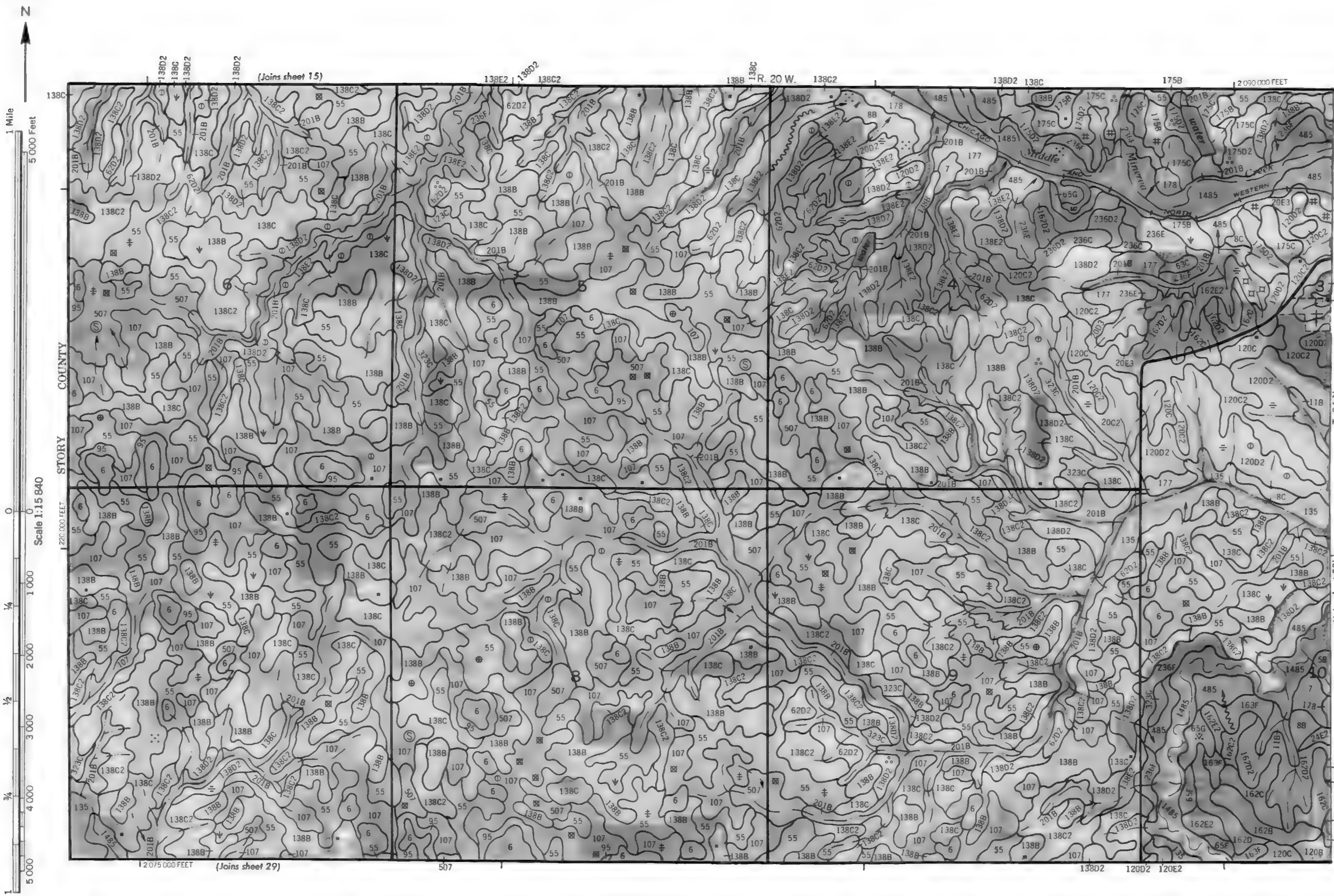

N
R. 19 W.
T. 85 N.
(Joins sheet 10)
(Joins sheet 16)
(Joins sheet 18)
(Joins sheet 24)
2 110 000 FEET
2 125 000 FEET
235 000 FEET
230 000 FEET
Mud Creek
Honey Creek
IOWA
RIVER
intermittent
28
29
26
27
32
33
34
35
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾

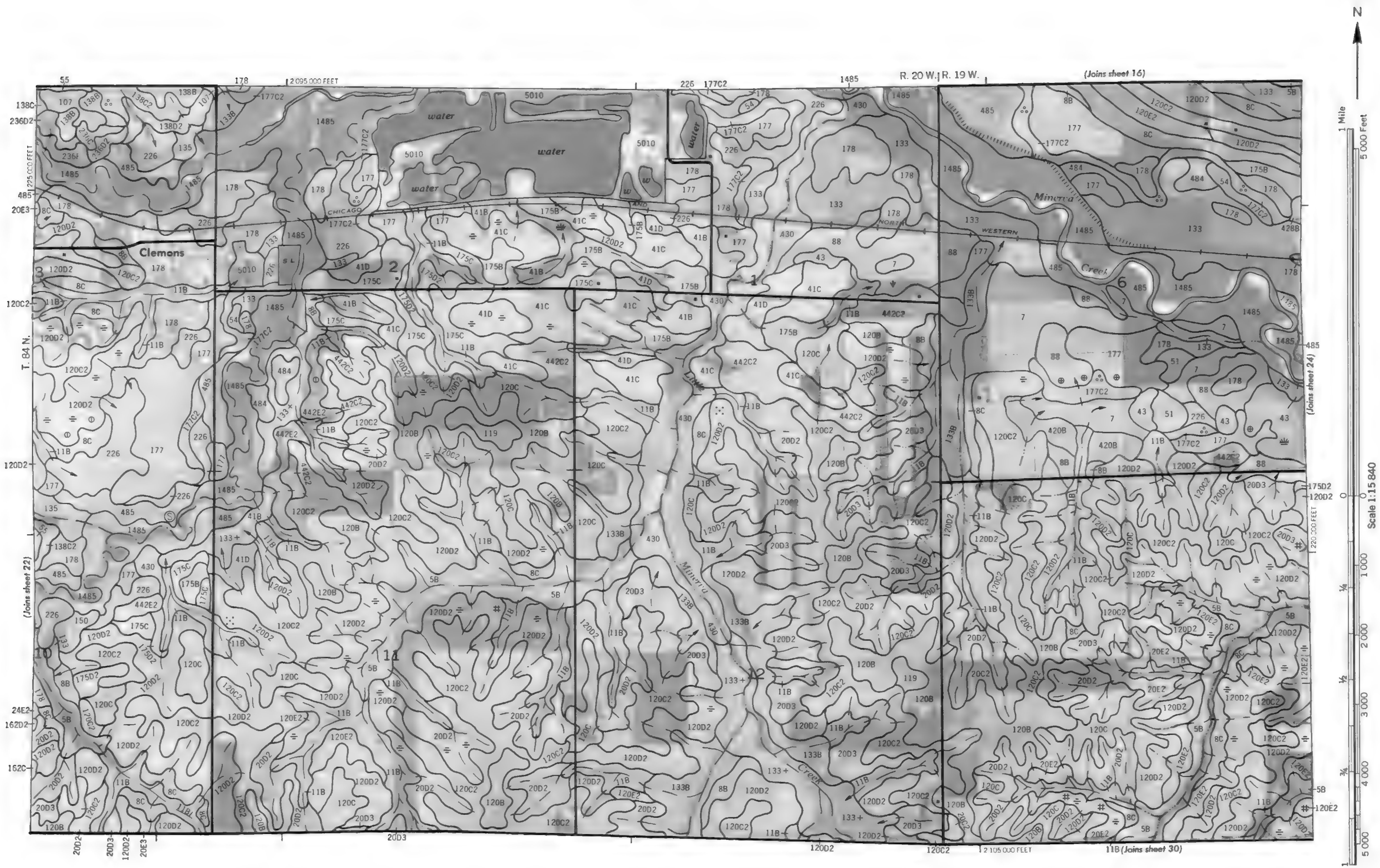

N
(Joins sheet 11)
R. 19 W.
R. 18 W.
2 145 000 FEET
235 000 FEET
T. 85 N.
(Joins sheet 17)
(Joins sheet 19)
(Joins sheet 25)
2 130 000 FEET
230 000 FEET
CHICAGO AND NORTH WESTERN
1 Mile
5 000 Feet
Scale 1:15 840
26
25
30
29
35
36
31
32


N
R. 18 W.
T. 85 N.
(Joins sheet 12)
(Joins sheet 18)
(Joins sheet 20)
(Joins sheet 26)
2 150 000 FEET
2 160 000 FEET
235 000 FEET
230 000 FEET
28
27
26
25
33
34
35
36
Asher Creek
water
1 Mile
5 000 Feet
Scale 1:15 840

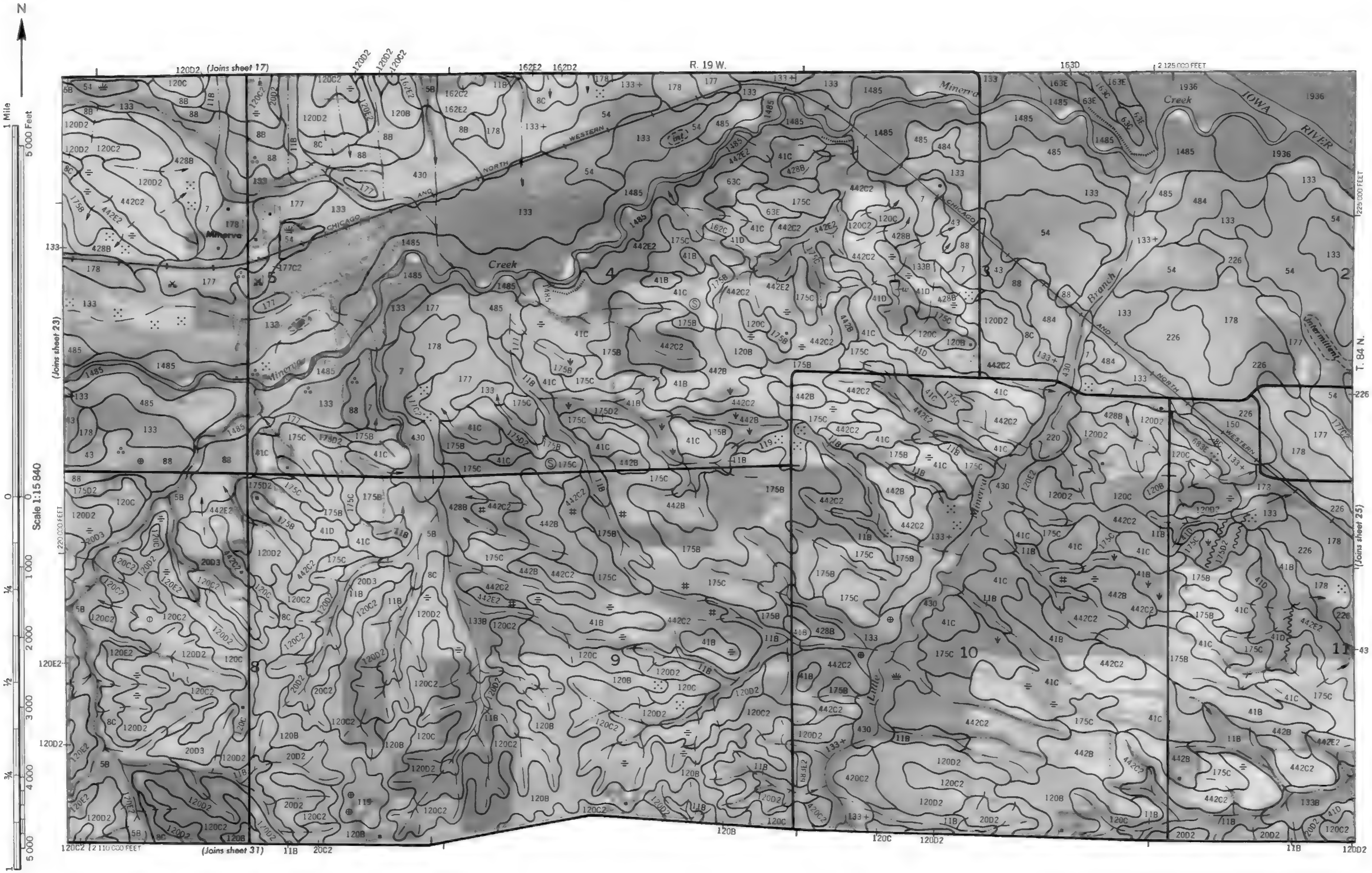

N
R. 18 W.
R. 17 W.
(Joins sheet 13)
(Joins sheet 19)
(Joins sheet 21)
(Joins sheet 27)
T. 85 N.
2 180 000 FEET
2 165 000 FEET
235 000 FEET
230 000 FEET
Scale 1:15 840
1 Mile
5 000 Feet
Burnett
Creek

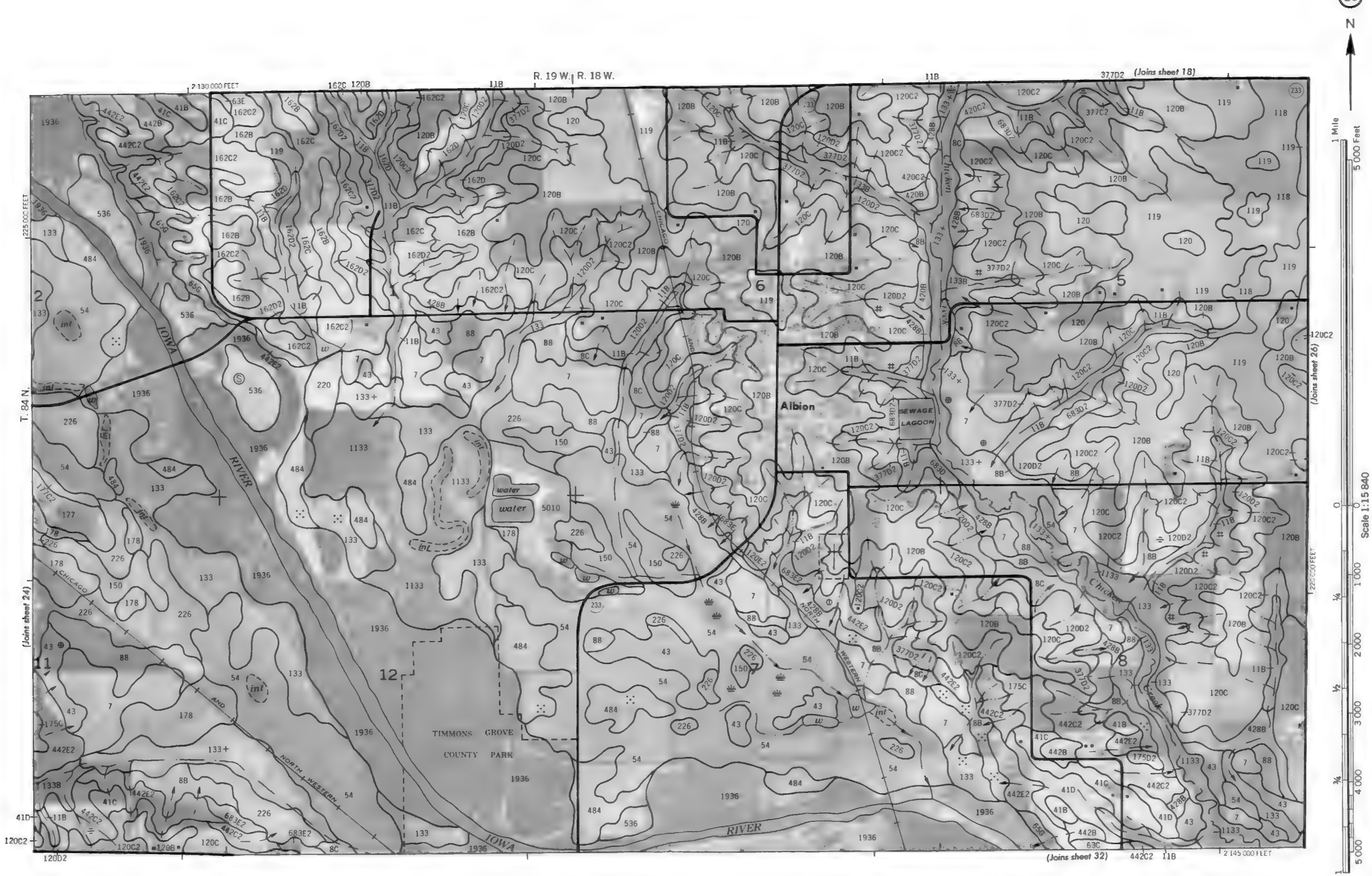

N
R. 17 W.
T. 85 N.
Joins sheet 14
(Joins sheet 20)
(Joins sheet 28)
2 185 000 FEET
2 200 000 FEET
235 000 FEET
230 000 FEET
27
26
25
34
35
36
TAMA COUNTY
Sugar Creek
Burnett Creek
CHICAGO AND NORTH WESTERN
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1
1 000
2 000
3 000
4 000
5 000


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 15)
(Joins sheet 29)
(Joins sheet 23)
R. 20 W.
T. 84 N.
STORY COUNTY
2 090 000 FEET
2 075 000 FEET
225 000 FEET
220 000 FEET
CHICAGO AND NORTH WESTERN
Middle Creek
Minerva
Water
4
3
5
6
7
8
9
10

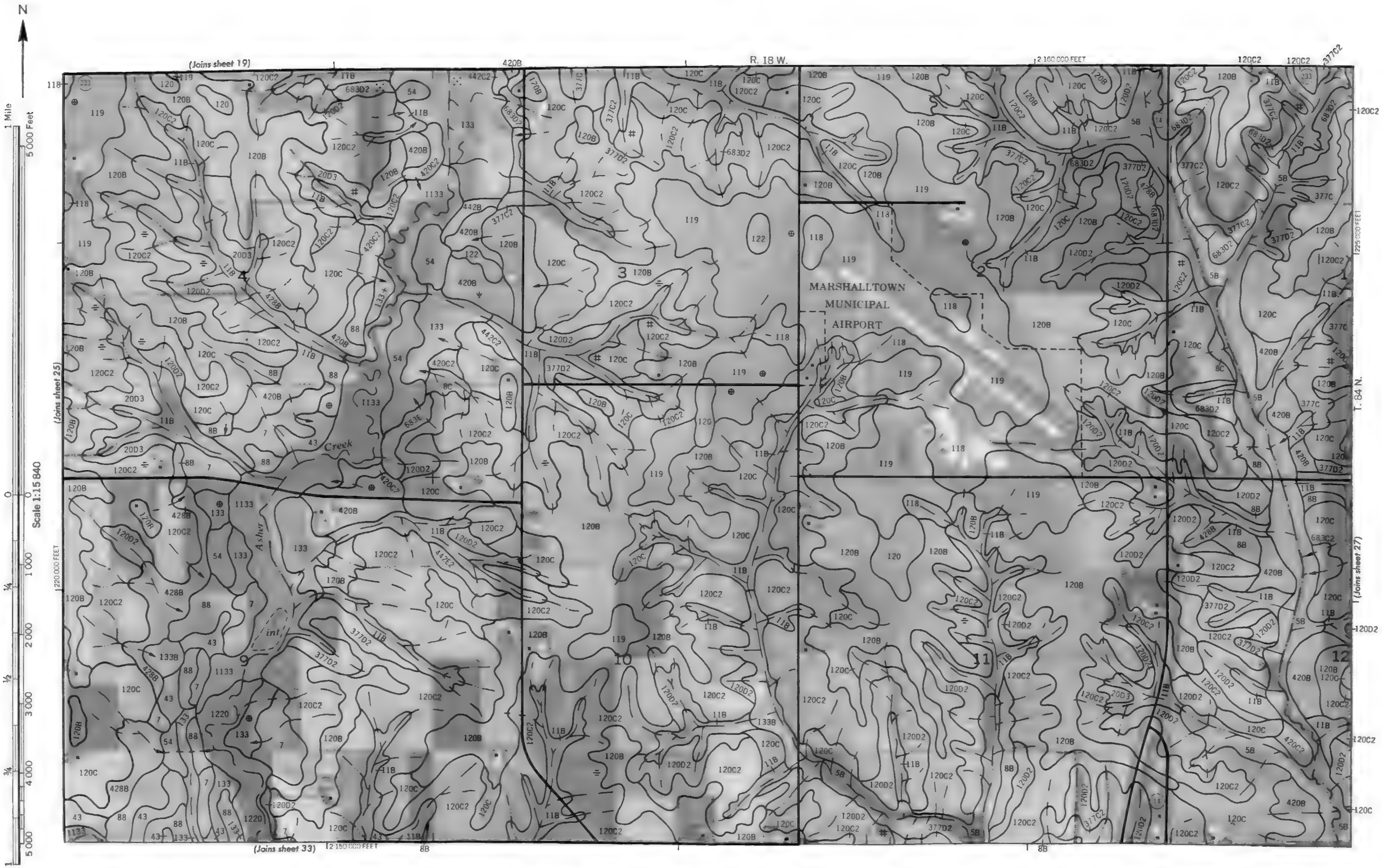

N
(Joins sheet 16)
(Joins sheet 22)
(Joins sheet 24)
(Joins sheet 30)
R. 20 W.
R. 19 W.
T. 84 N.
Clemons
water
Minerva Creek
Little
Chicago and North Western
2 095 000 FEET
2 105 000 FEET
225 000 FEET
220 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840

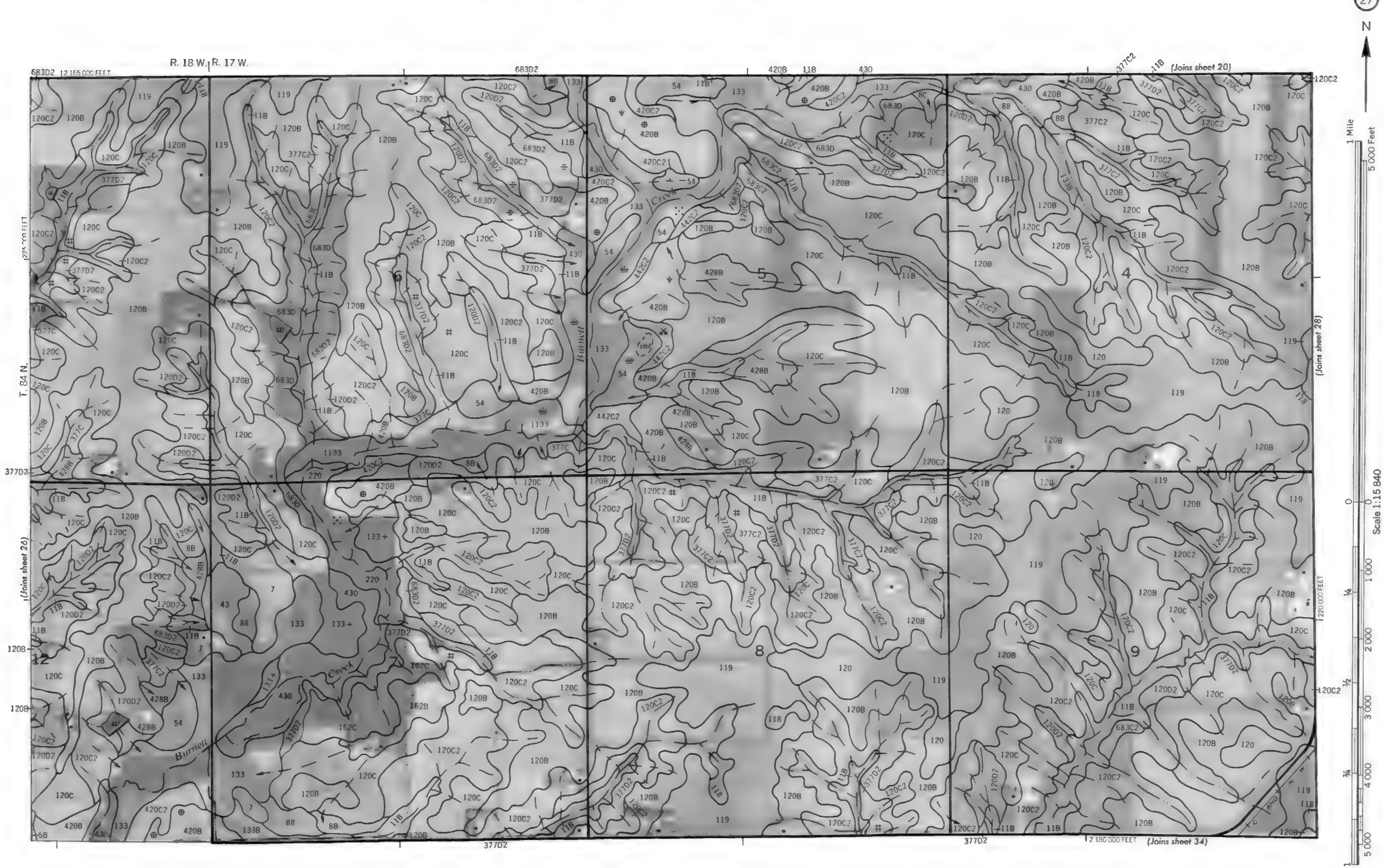
MARSHALL COUNTY, IOWA — SHEET NUMBER 24

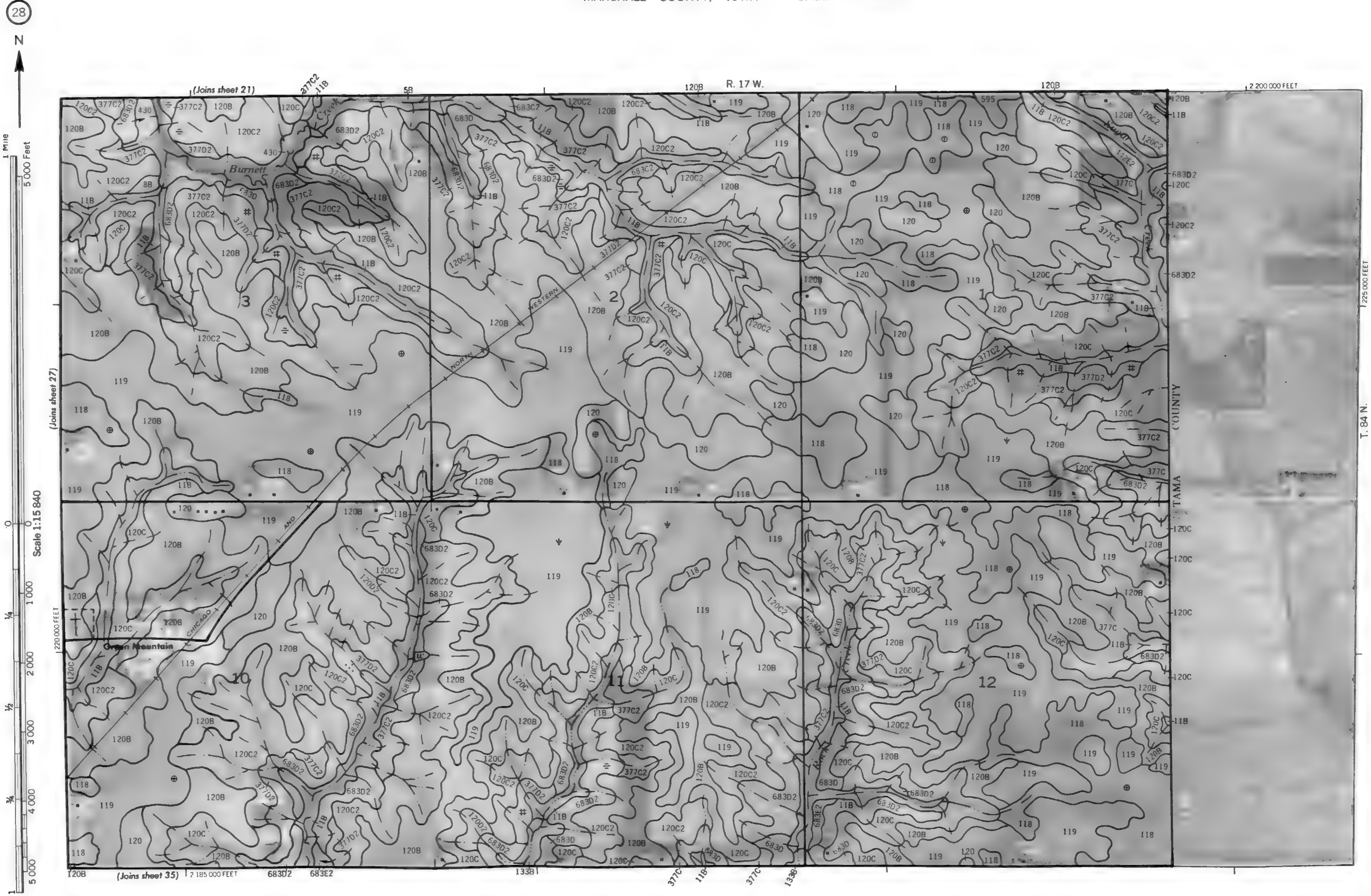


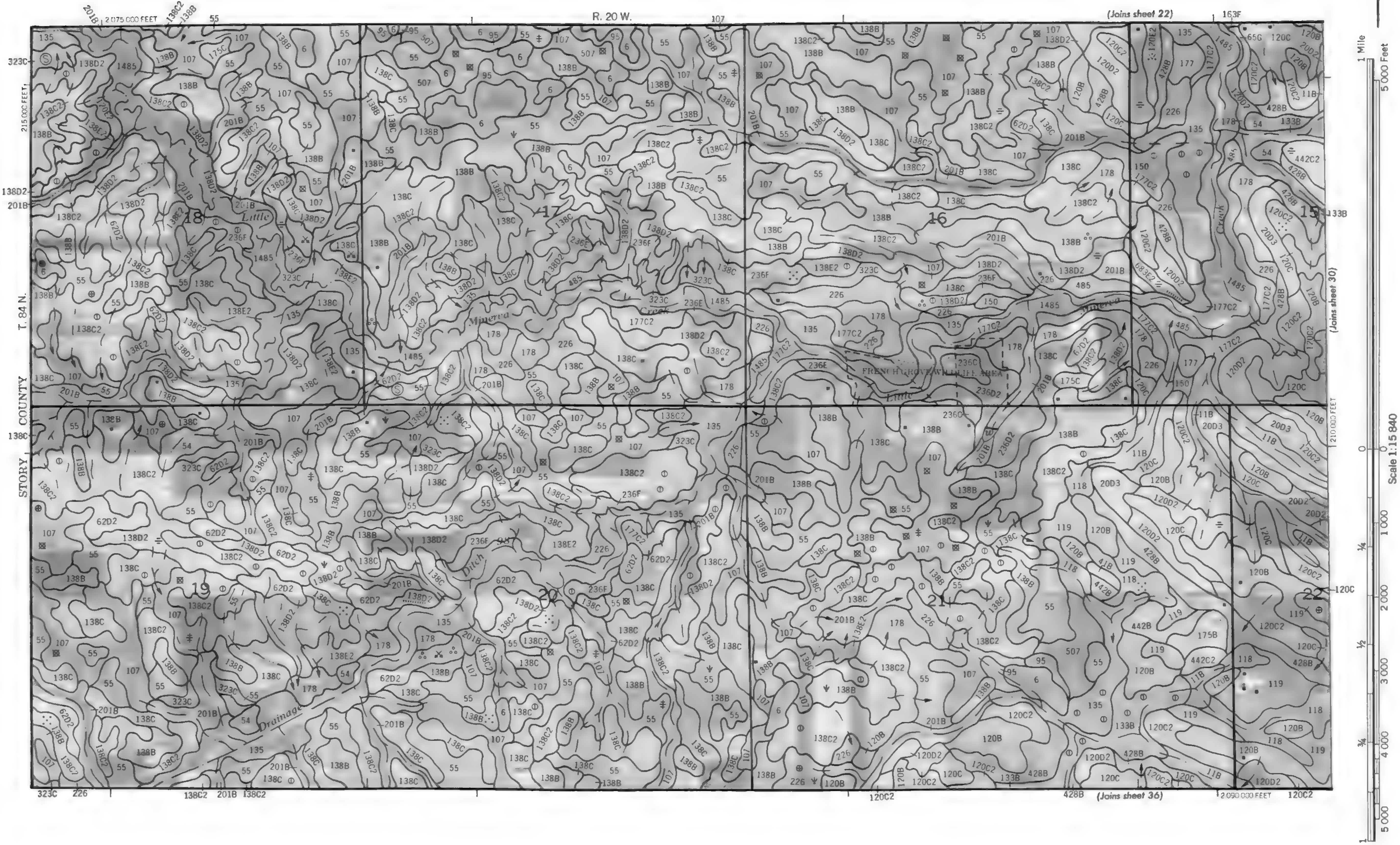

25
N
R. 19 W. | R. 18 W.
T. 84 N.
2 130 000 FEET
225 000 FEET
2 145 000 FEET
(Joins sheet 18)
(Joins sheet 26)
(Joins sheet 32)
(Joins sheet 24)
Albion
SEWAGE LAGOON
TIMMONS GROVE COUNTY PARK
IOWA RIVER
CHICAGO AND NORTH WESTERN
Chicken Creek
water
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000

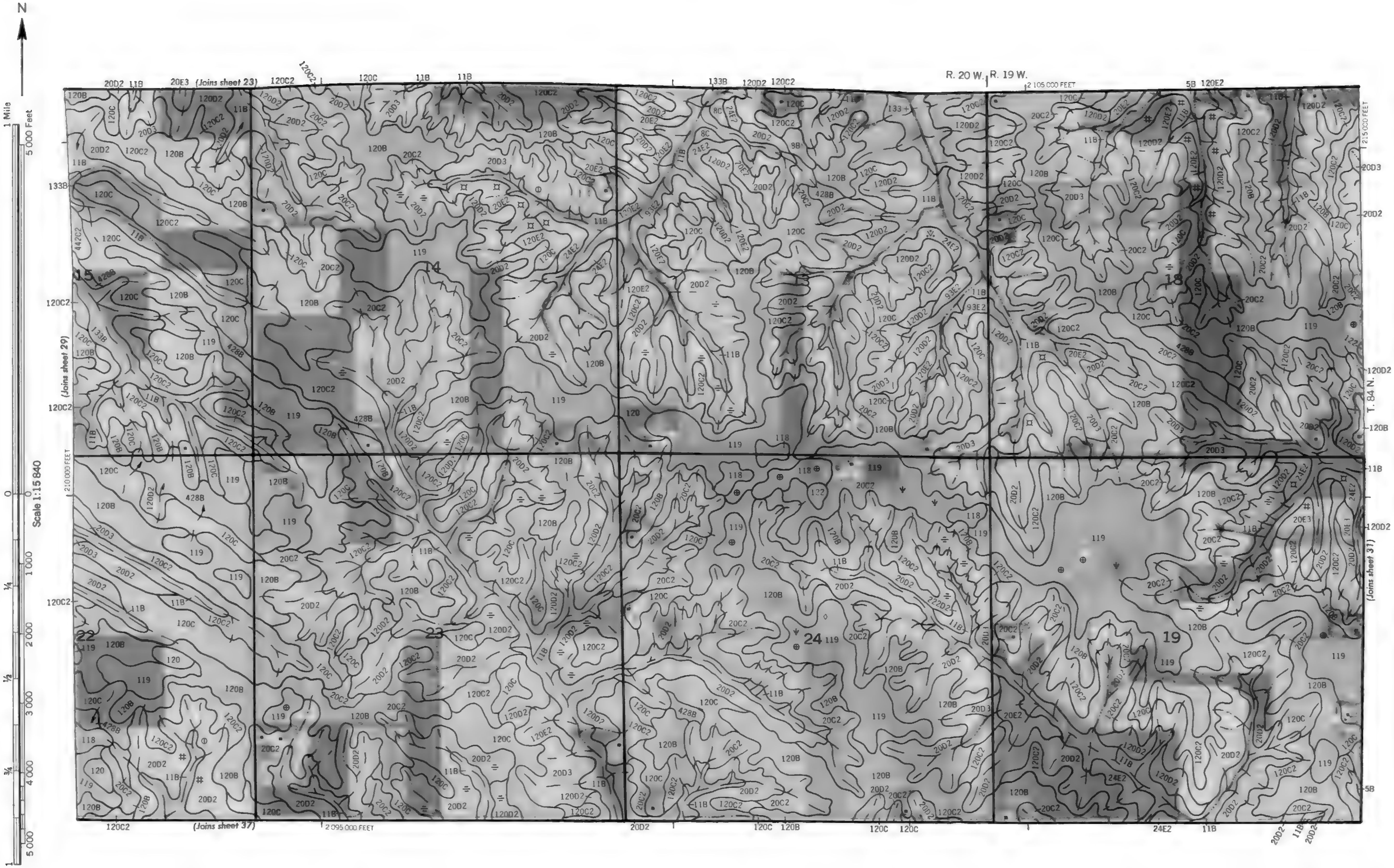
MARSHALL COUNTY, IOWA — SHEET NUMBER 26

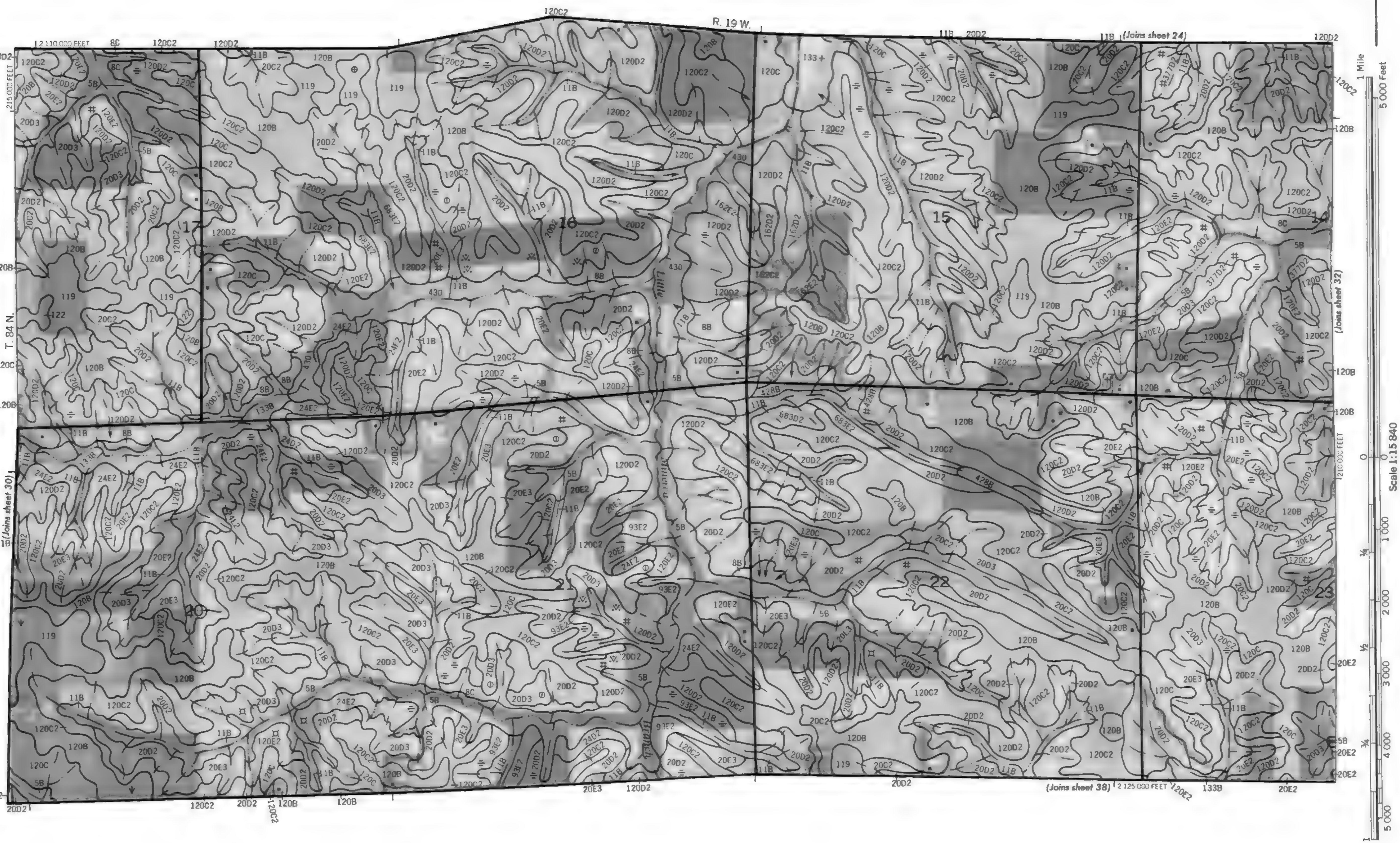


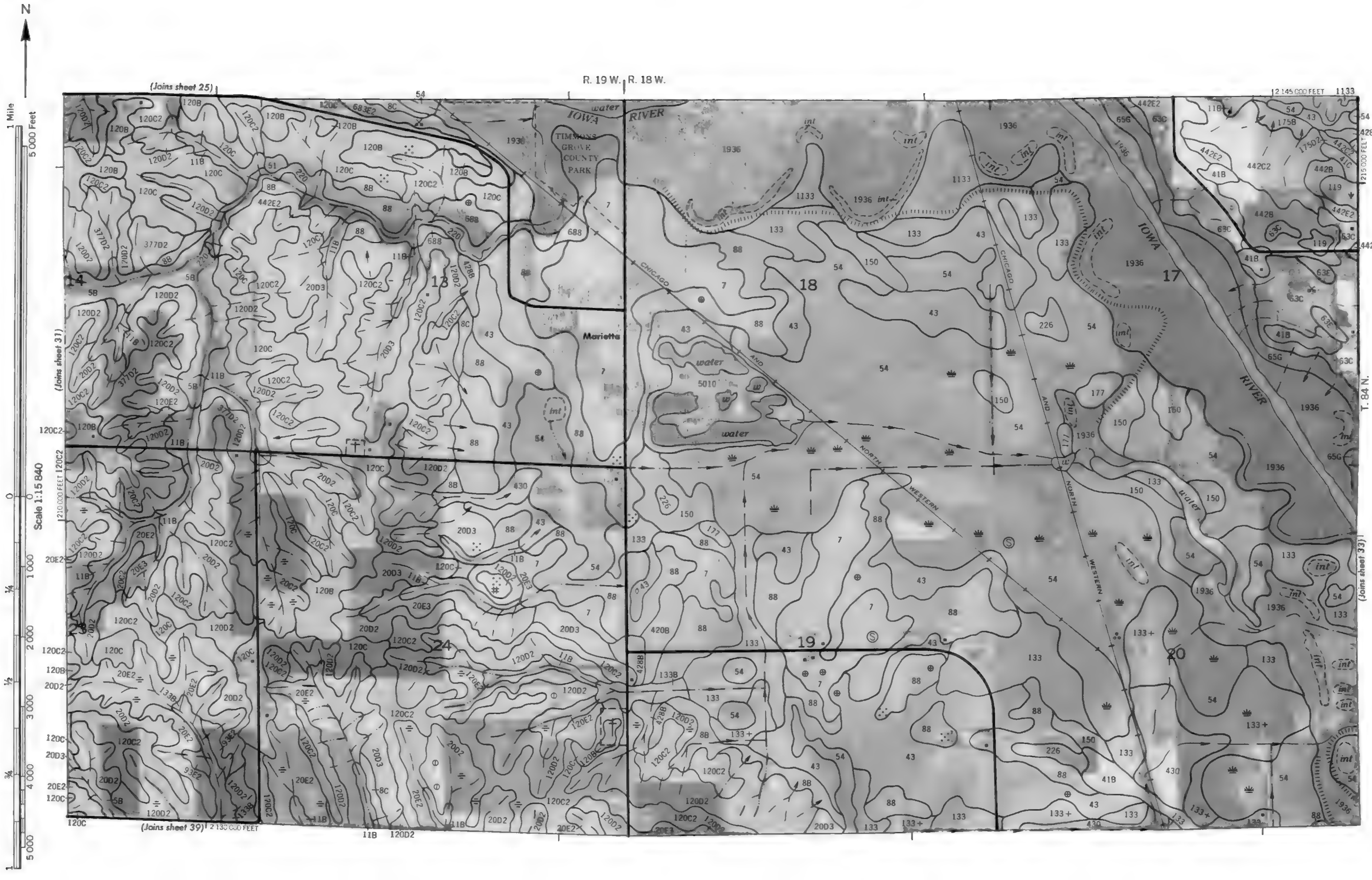

27
N
R. 18 W.
R. 17 W.
T. 84 N.
(Joins sheet 20)
(Joins sheet 28)
(Joins sheet 34)
(Joins sheet 26)
12 165 000 FEET
220 000 FEET
2 180 000 FEET
Burnett
Creek
4
5
6
7
8
9
12
1 Mile
5 000 Feet
Scale 1:15 840


28
N
(Joins sheet 21)
(Joins sheet 27)
(Joins sheet 35)
R. 17 W.
T. 84 N.
TAMA COUNTY
Burnett
Creek
Green Mountain
CHICAGO AND NORTH WESTERN
2 200 000 FEET
225 000 FEET
220 000 FEET
2 185 000 FEET
Scale 1:15 840
1 Mile
5 000 Feet

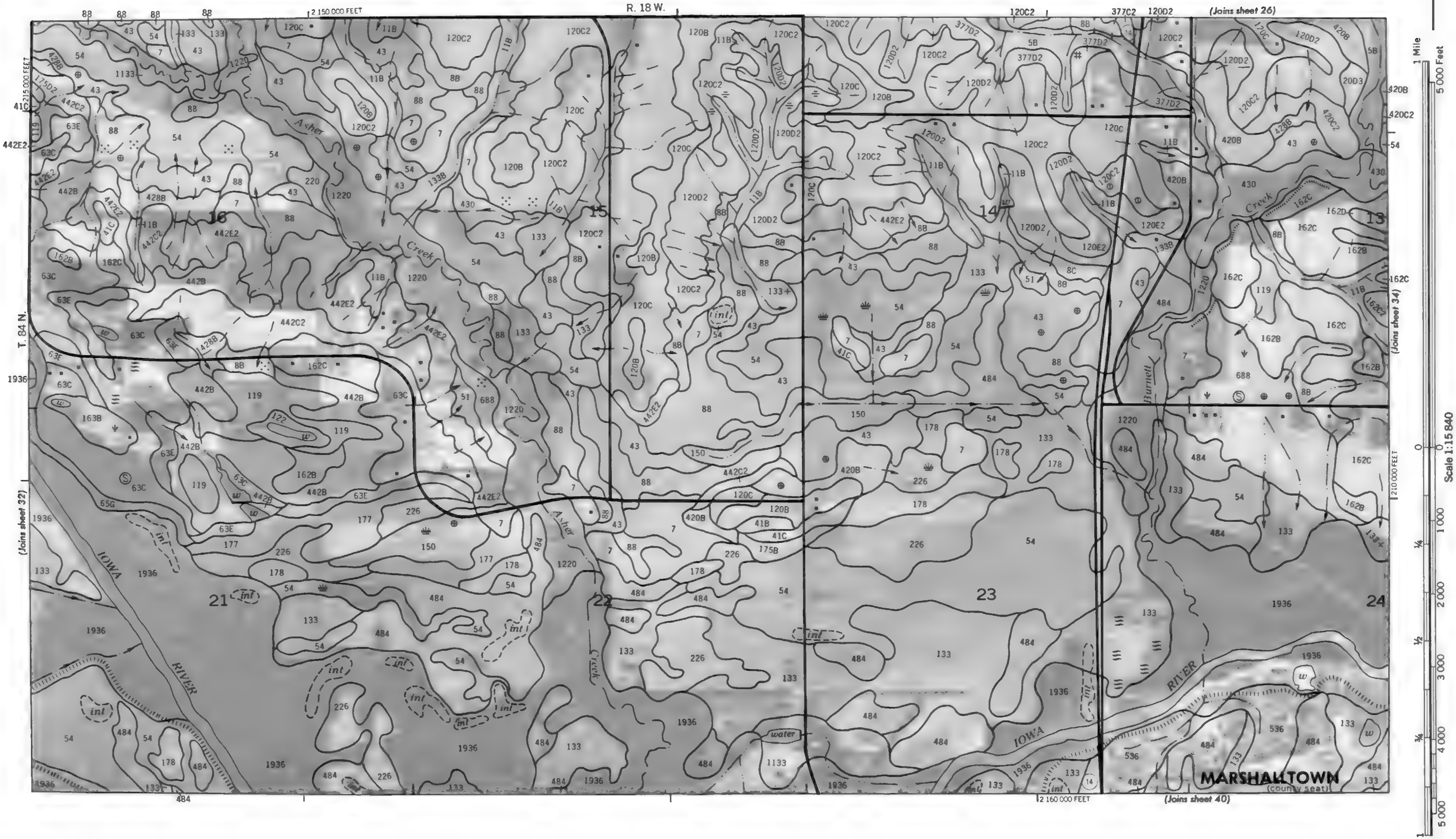

N
R. 20 W.
T. 84 N.
STORY COUNTY
(Joins sheet 22)
(Joins sheet 30)
(Joins sheet 36)
2 075 000 FEET
2 090 000 FEET
215 000 FEET
210 000 FEET
18
17
16
15
19
20
21
22
Little
Minerva
Creek
Ditch
Drainage
FRENCH GROVE WILDLIFE AREA
1 Mile
5 000 Feet
Scale 1:15 840
0
1000
2000
3000
4000
5000
¼
½
¾

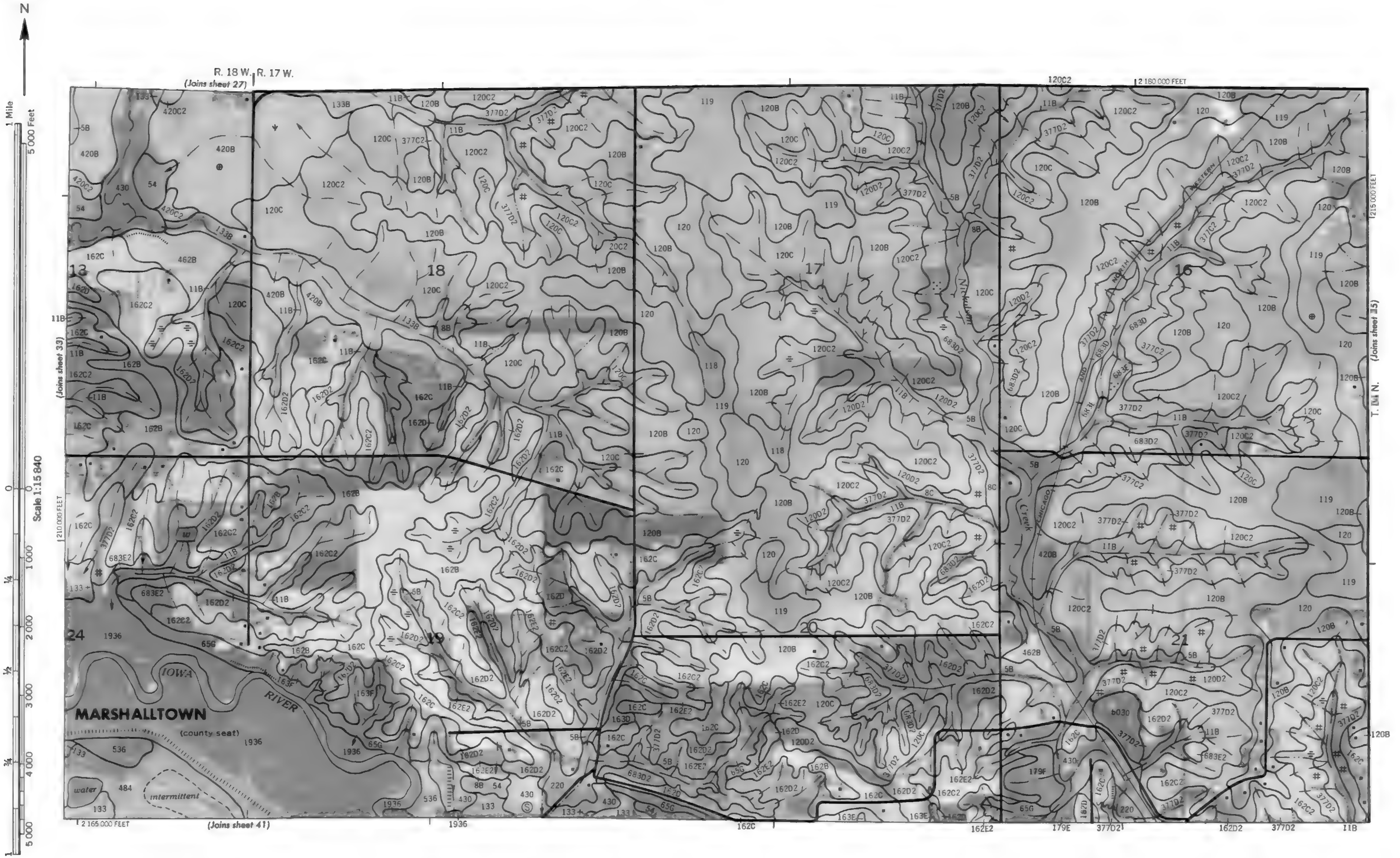

N
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾
(Joins sheet 23)
(Joins sheet 29)
(Joins sheet 31)
(Joins sheet 37)
R. 20 W.
R. 19 W.
T. 84 N.
2 105 000 FEET
2 095 000 FEET
210 000 FEET
215 000 FEET
14
15
18
19
22
23
24

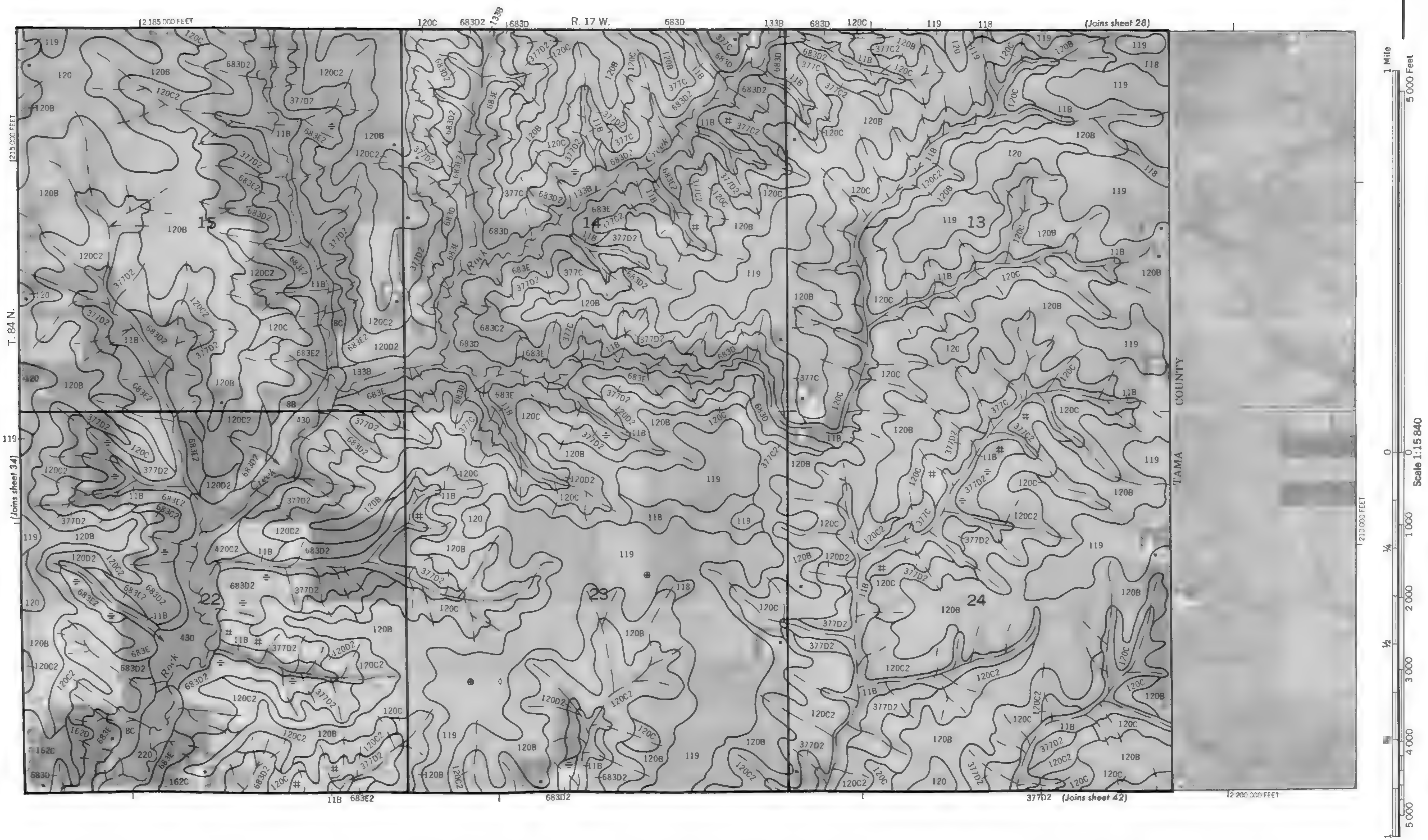

N
R. 19 W.
T. 84 N.
(Joins sheet 24)
(Joins sheet 32)
(Joins sheet 38)
(Joins sheet 30)
2 110 000 FEET
215 000 FEET
2 125 000 FEET
210 000 FEET
Little
Minerva
Branch
17
16
15
14
20
21
22
23
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000

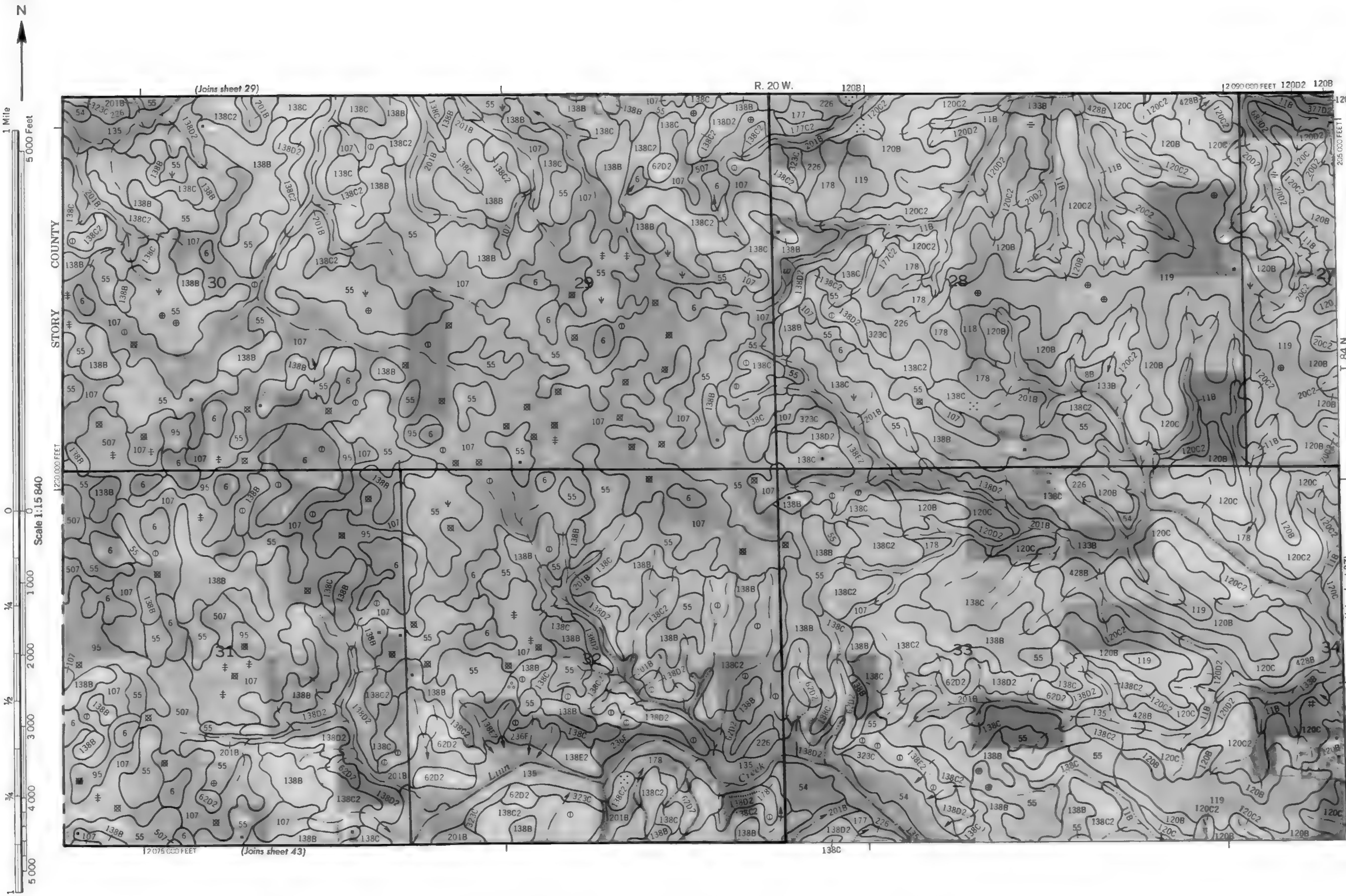

N
(Joins sheet 25)
R. 19 W.
R. 18 W.
2 145 000 FEET
IOWA RIVER
TIMMONS GROVE COUNTY PARK
Marietta
CHICAGO AND NORTH WESTERN
(Joins sheet 31)
(Joins sheet 33)
(Joins sheet 39)
2 130 000 FEET
210 000 FEET
215 000 FEET
T. 84 N.
14
13
18
17
23
24
19
20
Scale 1:15 840
1 Mile
5 000 Feet

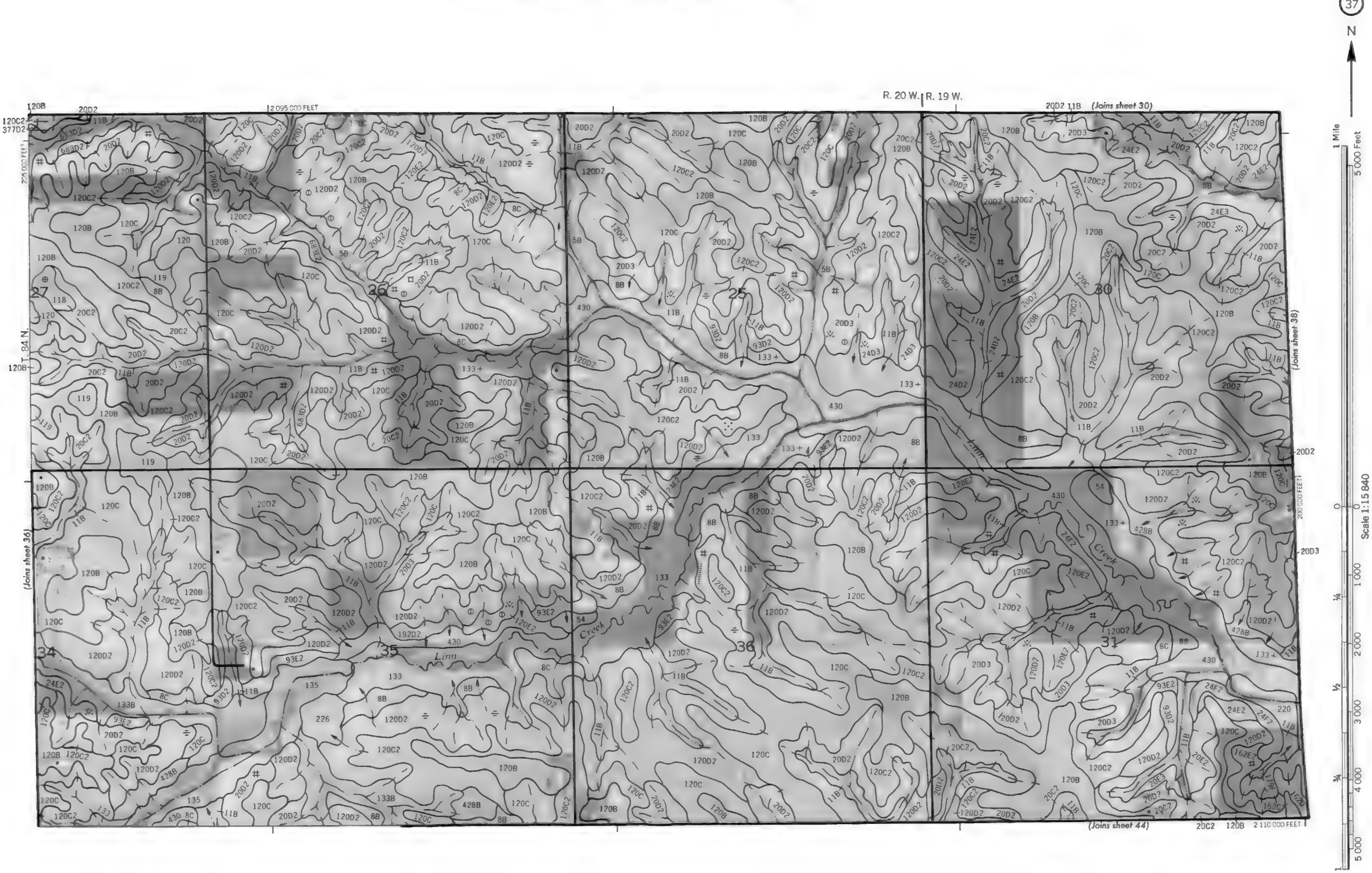
MARSHALL COUNTY, IOWA — SHEET NUMBER 33

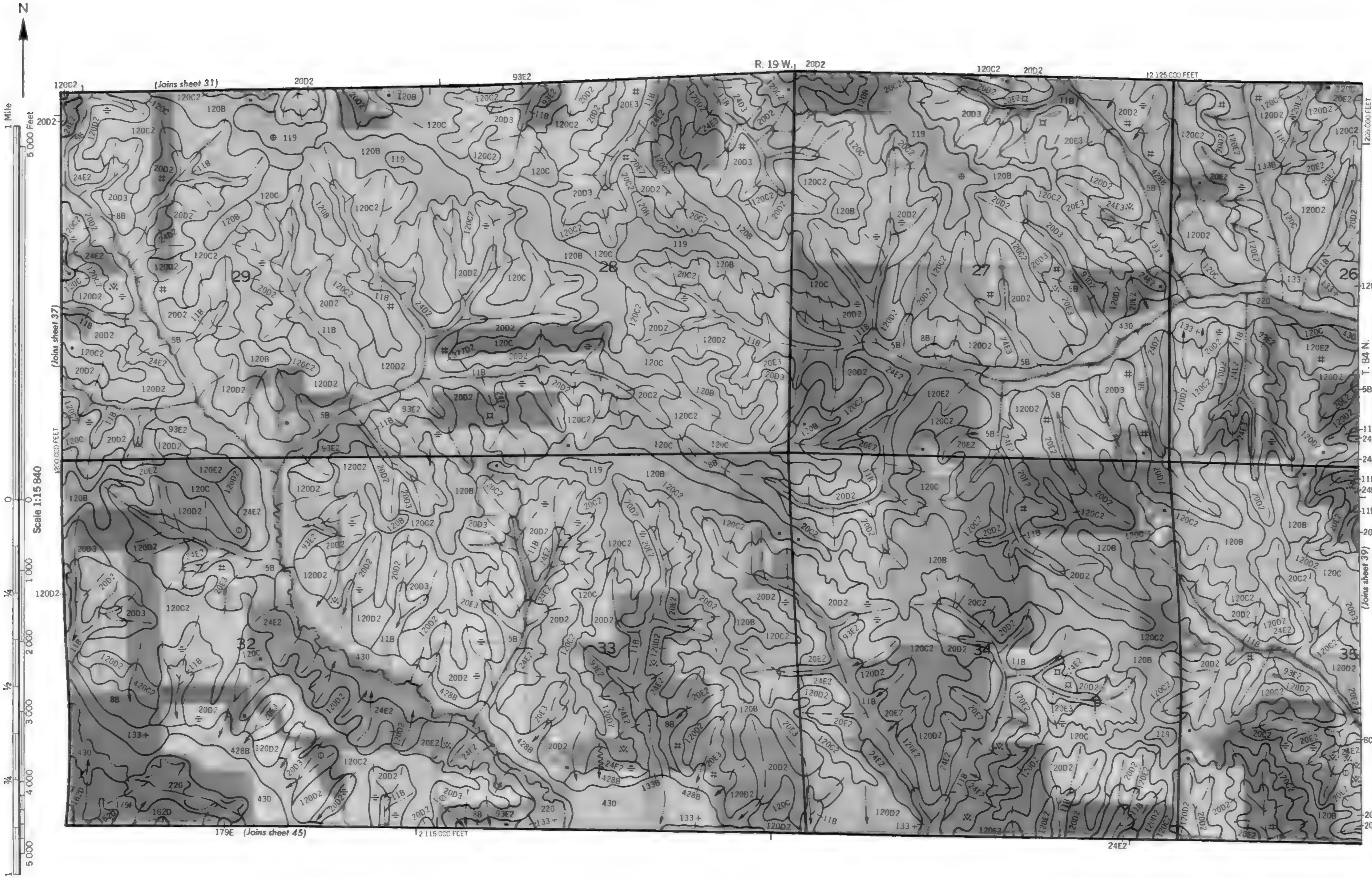


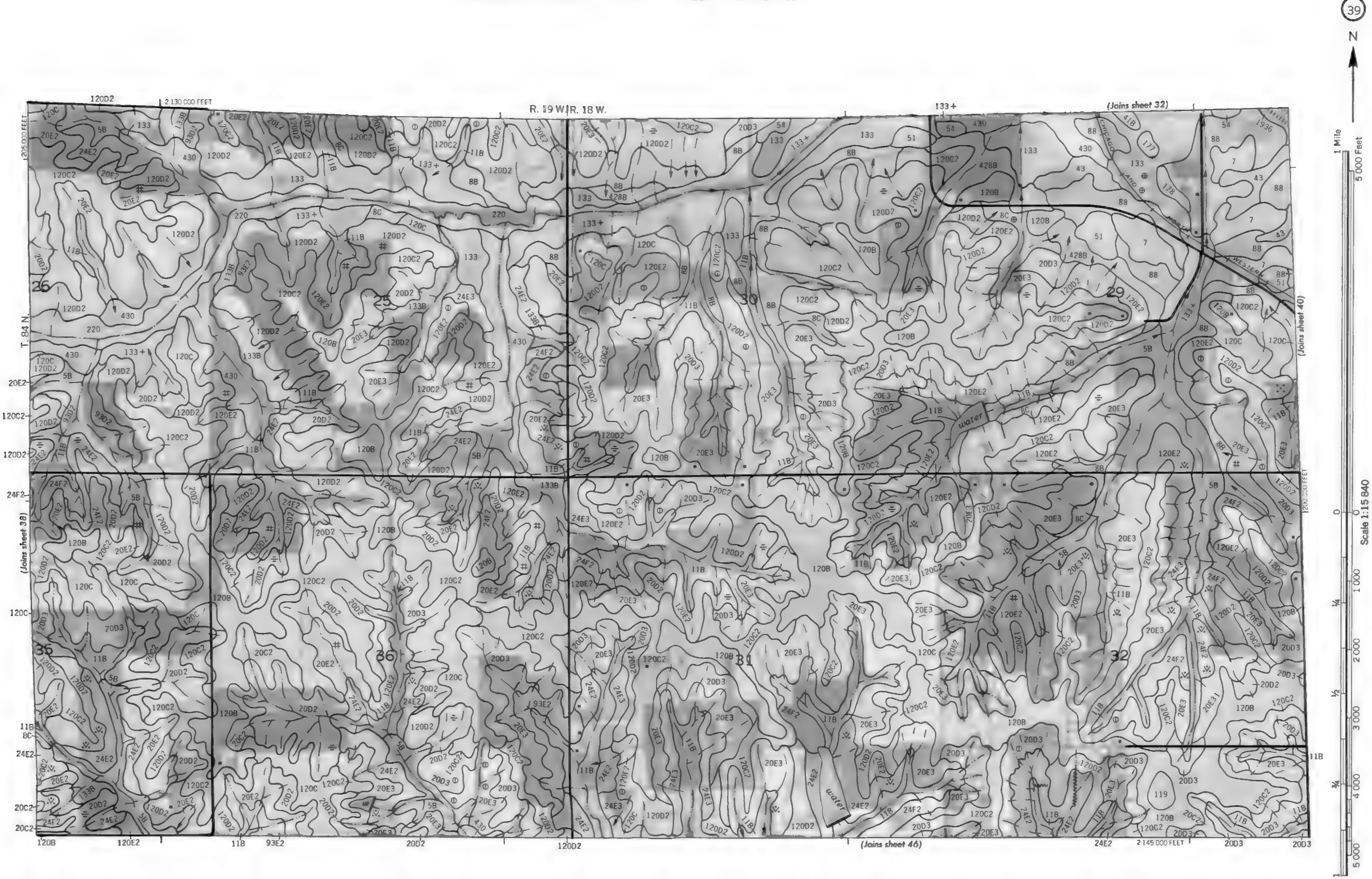

N
R. 18 W. R. 17 W.
(Joins sheet 27)
(Joins sheet 33)
(Joins sheet 35)
(Joins sheet 41)
T. 84 N.
2 180 000 FEET
2 165 000 FEET
215 000 FEET
210 000 FEET
MARSHALLTOWN
(county seat)
IOWA
RIVER
water
intermittent
Creek
1 Mile
5 000 Feet
Scale 1:15 840

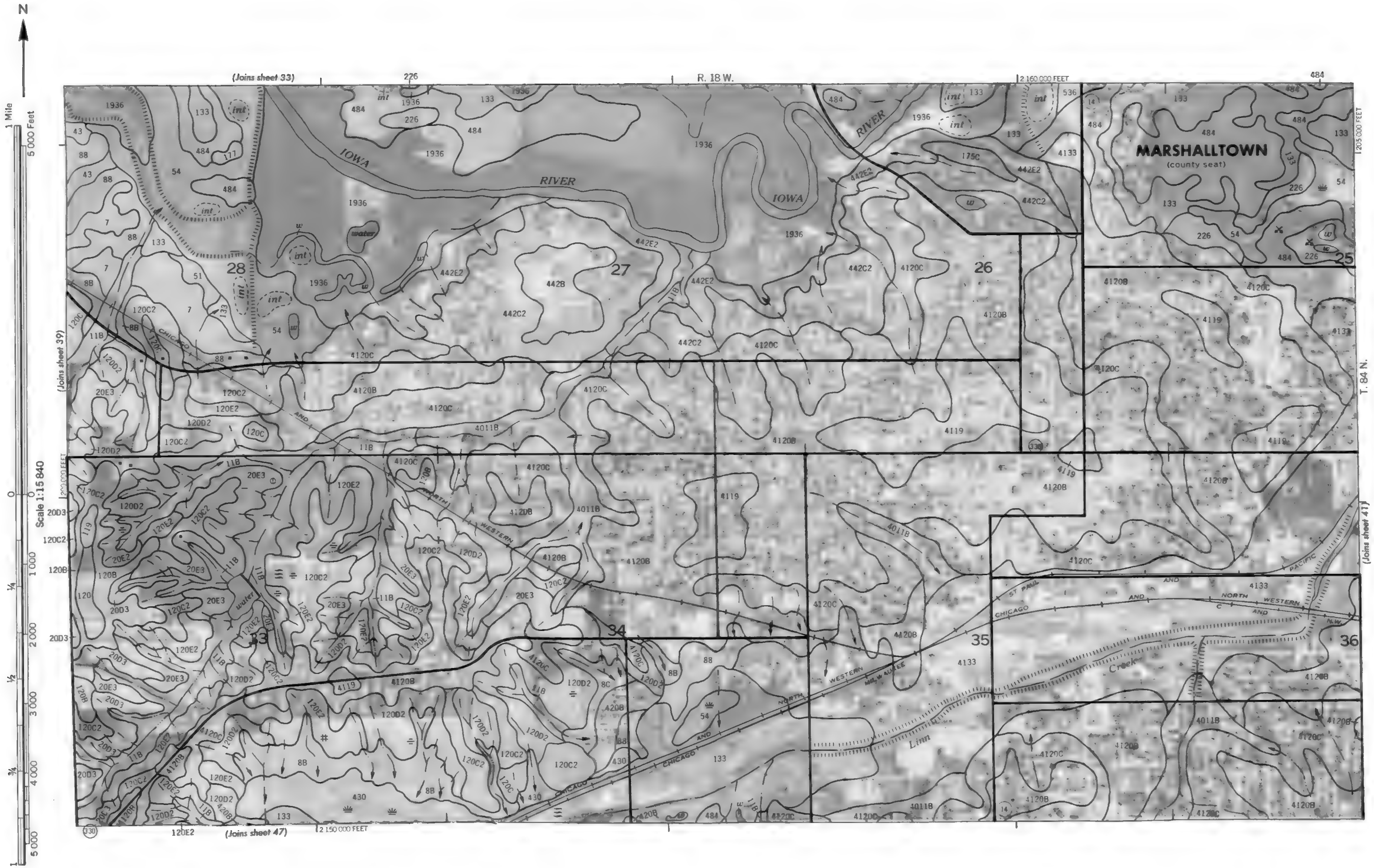

35
N
R. 17 W.
(Joins sheet 28)
(Joins sheet 34)
(Joins sheet 42)
T. 84 N.
TAMA COUNTY
2 185 000 FEET
2 200 000 FEET
215 000 FEET
210 000 FEET
Rock Creek
15
14
13
22
23
24
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
1 000
2 000
3 000
4 000
5 000

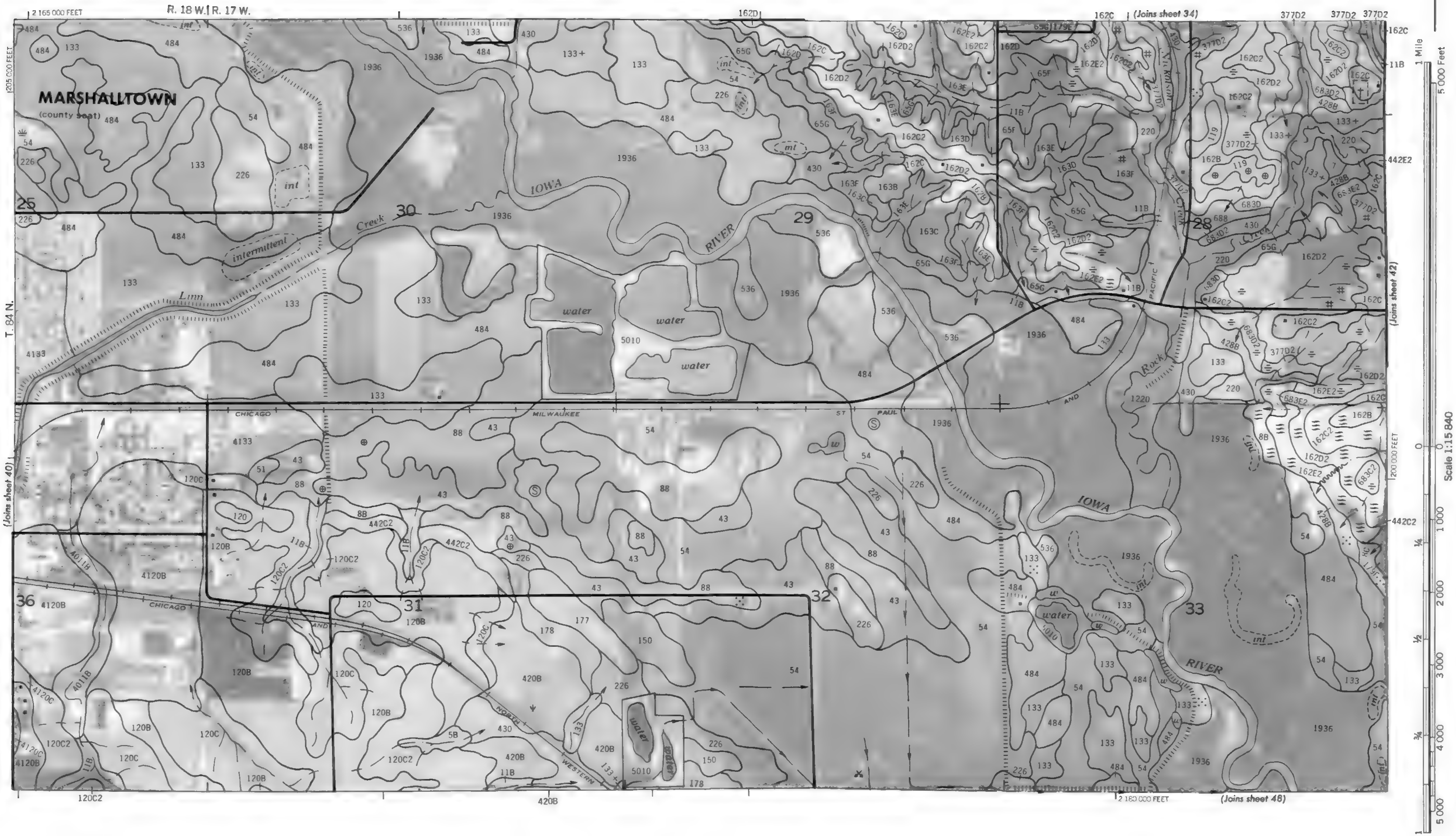

N
(Joins sheet 29)
R. 20 W.
(Joins sheet 37)
(Joins sheet 43)
STORY COUNTY
T. 84 N.
30
29
28
27
31
32
33
34
Linn Creek
2 090 000 FEET
205 000 FEET
220 000 FEET
2 075 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾

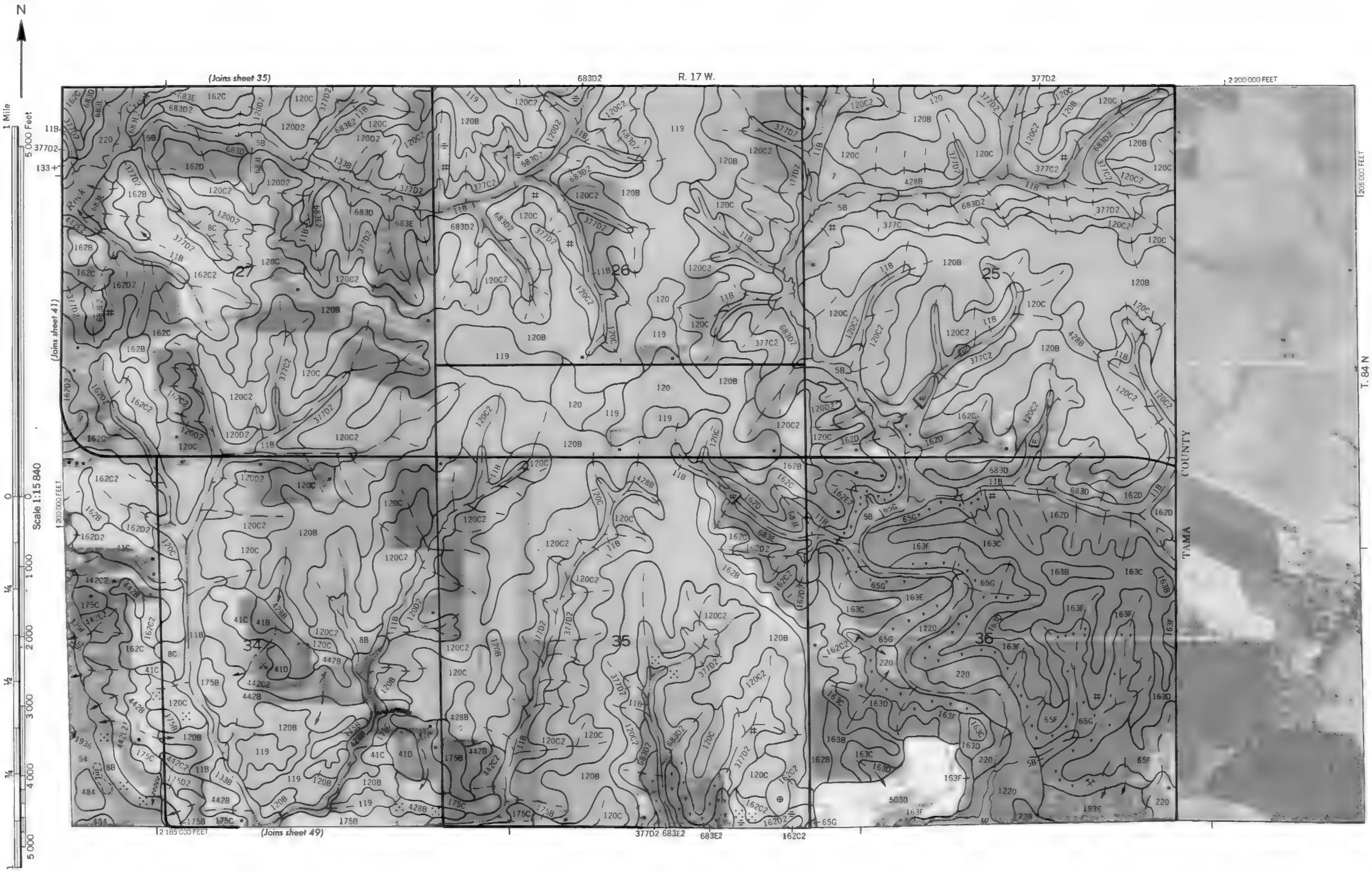

37
N
R. 20 W.
R. 19 W.
T. 84 N.
(Joins sheet 30)
(Joins sheet 38)
(Joins sheet 44)
(Joins sheet 36)
12 095 000 FEET
205 000 FEET
200 000 FEET
2 110 000 FEET
27
26
25
30
34
35
36
31
Linn
Creek
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000

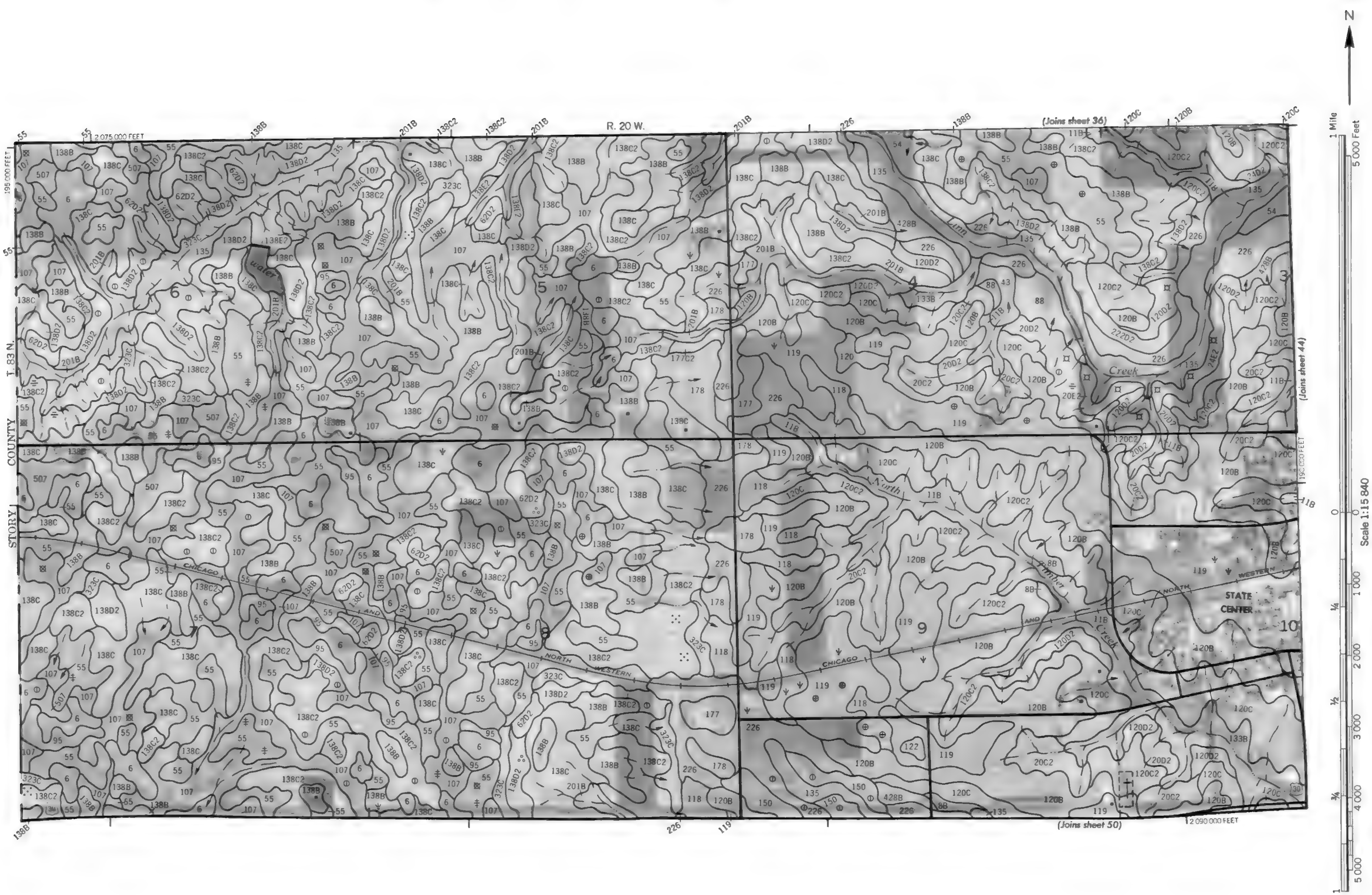

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 31)
(Joins sheet 37)
(Joins sheet 39)
(Joins sheet 45)
R. 19 W.
T. 84 N.
2 125 000 FEET
205 000 FEET
1 200 000 FEET
2 115 000 FEET
29
28
27
26
32
33
34
35

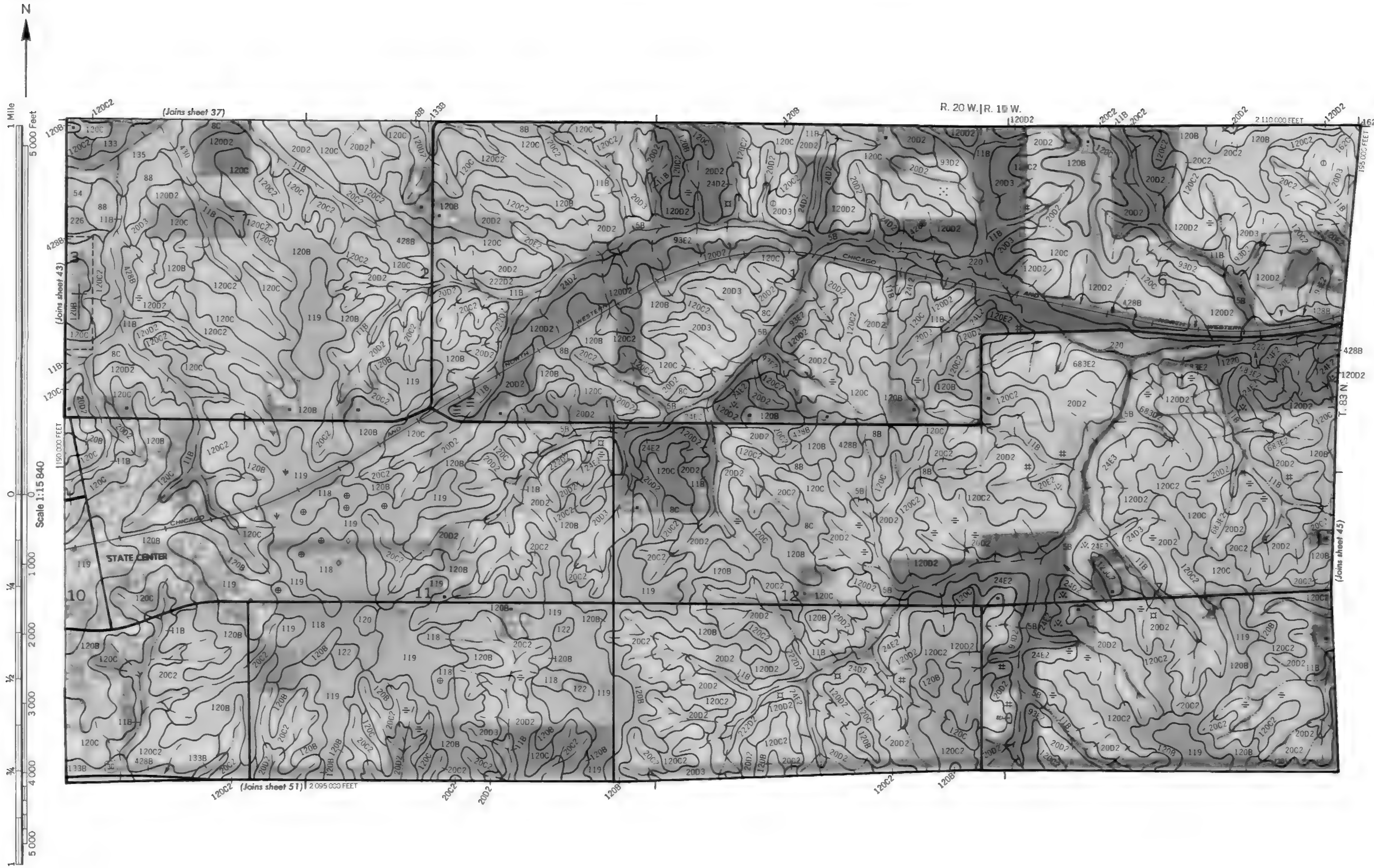

39
N
(Joins sheet 32)
(Joins sheet 40)
(Joins sheet 46)
(Joins sheet 38)
R. 19 W.
R. 18 W.
T. 84 N.
2 130 000 FEET
2 145 000 FEET
205 000 FEET
200 000 FEET
CHICAGO AND NORTH WESTERN
water
26
25
30
29
35
36
31
32
1 Mile
5 000 Feet
Scale 1:15 840
¼
½
¾
0
1 000
2 000
3 000
4 000
5 000

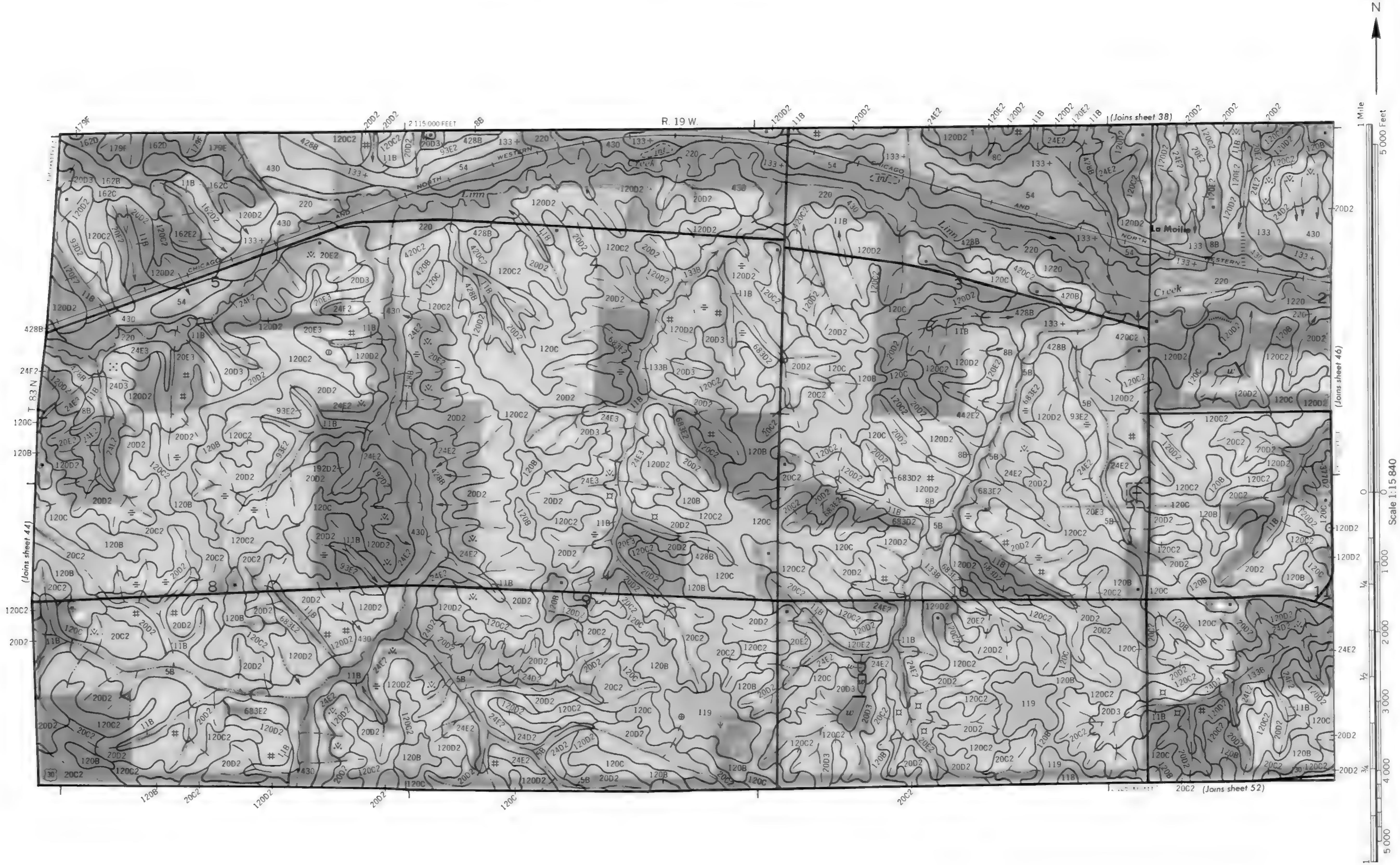

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 33)
(Joins sheet 39)
(Joins sheet 41)
(Joins sheet 47)
R. 18 W.
T. 84 N.
2 160 000 FEET
2 150 000 FEET
205 000 FEET
200 000 FEET
MARSHALLTOWN
(county seat)
IOWA
RIVER
water
Linn
Creek
CHICAGO AND NORTH WESTERN
CHICAGO, MILWAUKEE, ST PAUL AND PACIFIC
28
27
26
25
33
34
35
36

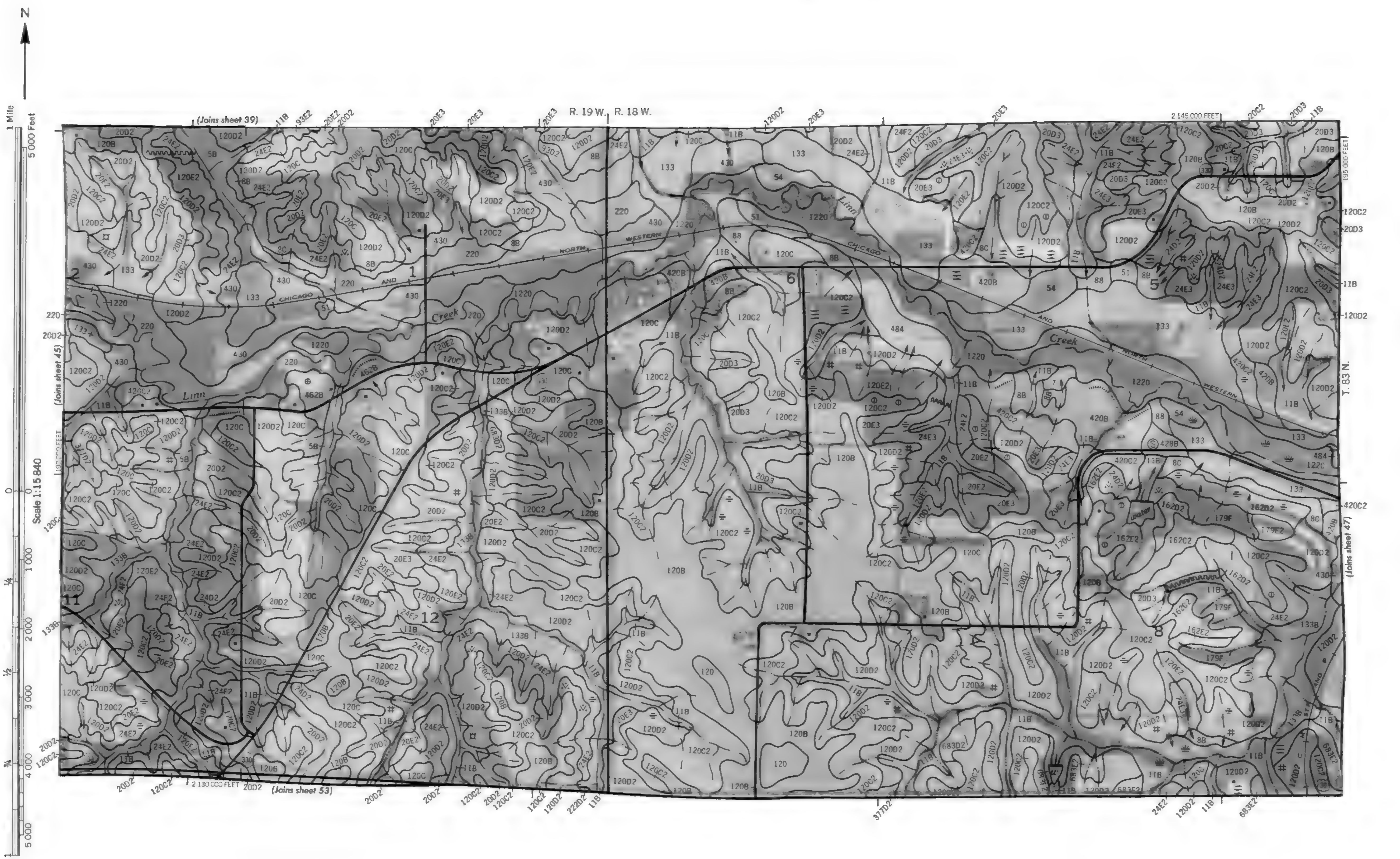

N
2 165 000 FEET
R. 18 W. | R. 17 W.
(Joins sheet 34)
205 000 FEET
MARSHALLTOWN
(county seat)
T. 84 N.
(Joins sheet 40)
(Joins sheet 42)
(Joins sheet 48)
2 180 000 FEET
200 000 FEET
IOWA
RIVER
Linn
Creek
intermittent
Rock
Creek
water
CHICAGO
MILWAUKEE
ST
PAUL
AND
PACIFIC
CHICAGO
AND
NORTH
WESTERN
25
30
29
28
36
31
32
33
1 Mile
5 000 Feet
Scale 1:15 840
0
1000
2000
3000
4000
5000
¼
½
¾


42
N
(Joins sheet 35)
R. 17 W.
2 200 000 FEET
205 000 FEET
T. 84 N
TAMA COUNTY
(Joins sheet 41)
(Joins sheet 49)
2 185 000 FEET
200 000 FEET
27
26
25
34
35
36
Rock
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾

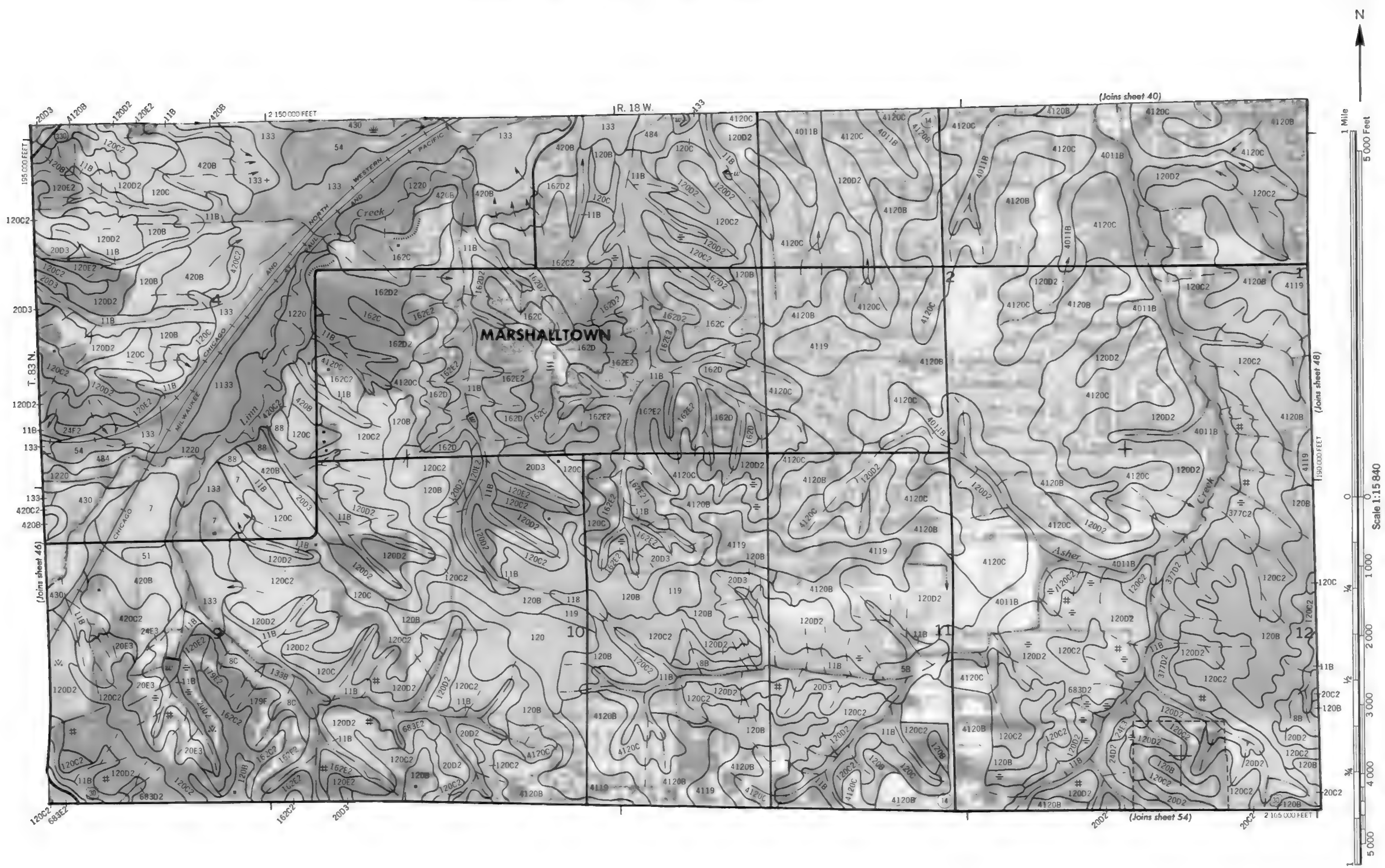

N
R. 20 W.
T. 83 N.
STORY COUNTY
(Joins sheet 36)
(Joins sheet 44)
(Joins sheet 50)
2 075 000 FEET
2 090 000 FEET
195 000 FEET
STATE CENTER
CHICAGO AND NORTH WESTERN
Linn Creek
North Timber Creek
water
1 Mile
5 000 Feet
Scale 1:15 840

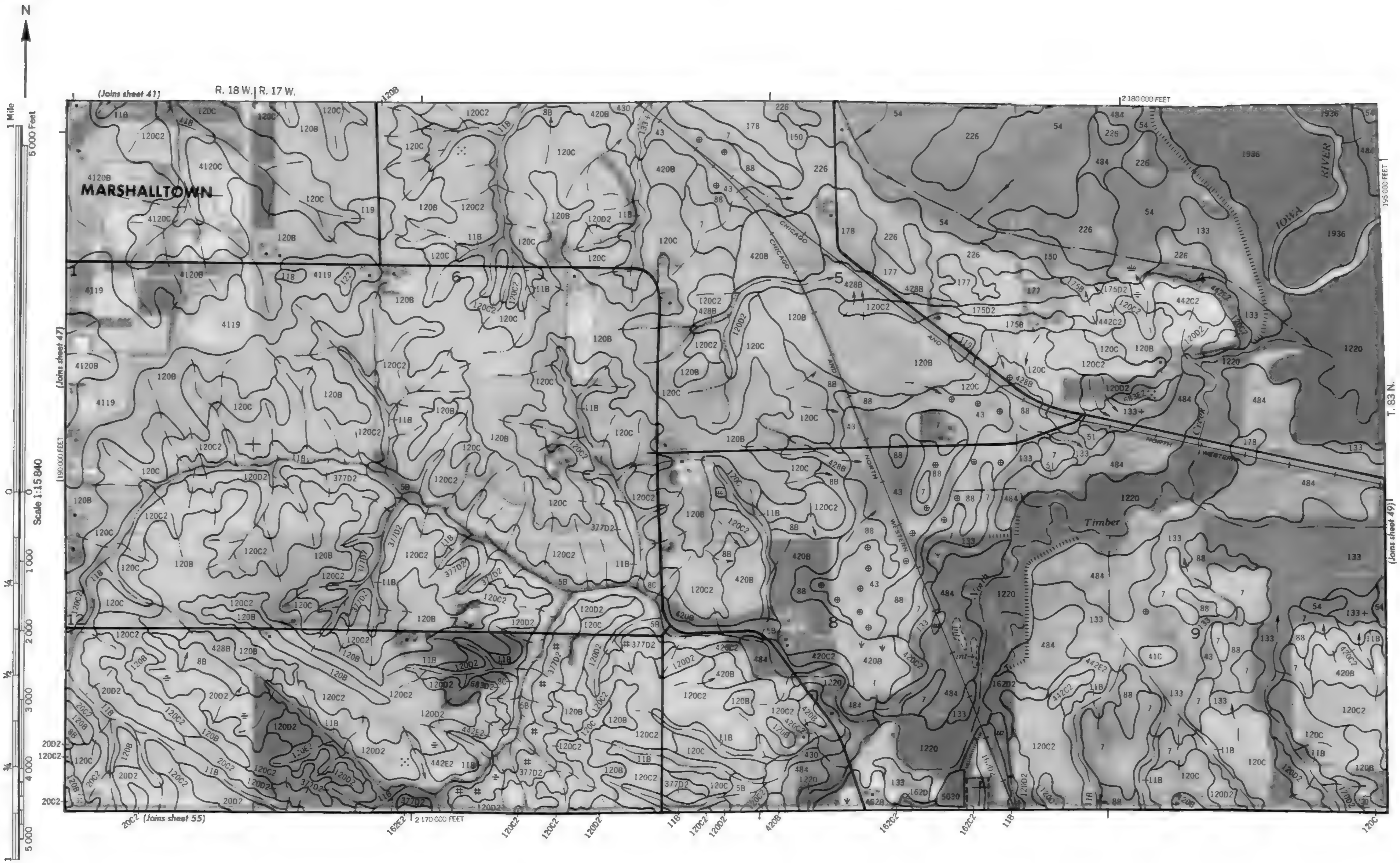

N
(Joins sheet 37)
(Joins sheet 43)
(Joins sheet 45)
(Joins sheet 51)
R. 20 W. | R. 19 W.
T. 83 N.
2 110 000 FEET
2 095 000 FEET
195 000 FEET
190 000 FEET
STATE CENTER
CHICAGO AND NORTH WESTERN
Scale 1:15 840
1 Mile
5 000 Feet
1 000
2 000
3 000
4 000
5 000

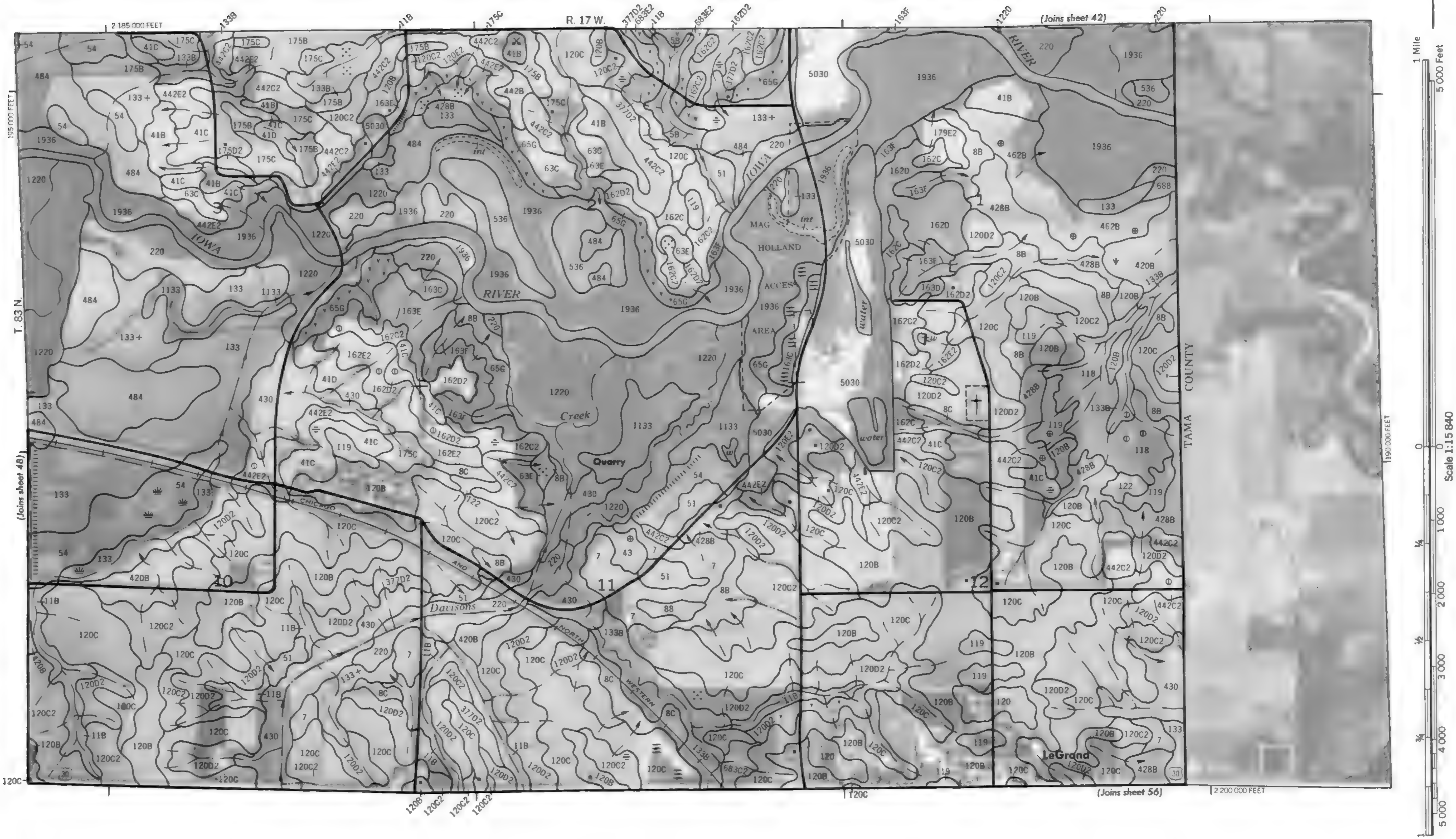

N
R. 19 W.
T. 83 N.
(Joins sheet 38)
(Joins sheet 44)
(Joins sheet 46)
(Joins sheet 52)
2 115 000 FEET
La Moille
Linn Creek
Chicago and North Western
1 Mile
5 000 Feet
Scale 1:15 840

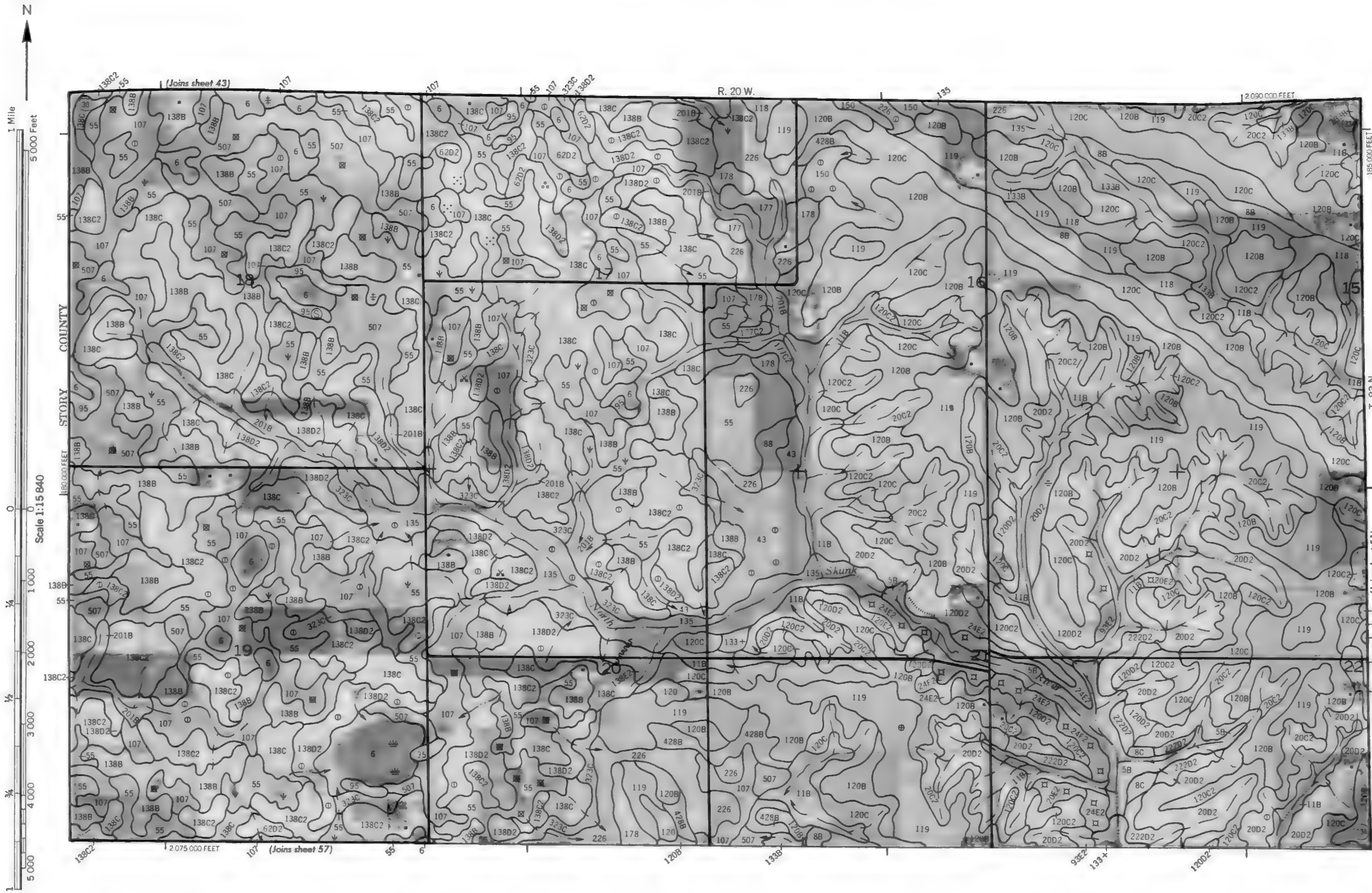

N
R. 19 W.
R. 18 W.
T. 83 N.
(Joins sheet 39)
(Joins sheet 45)
(Joins sheet 47)
(Joins sheet 53)
2 145 000 FEET
2 130 000 FEET
195 000 FEET
190 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840
Linn Creek
Chicago and North Western

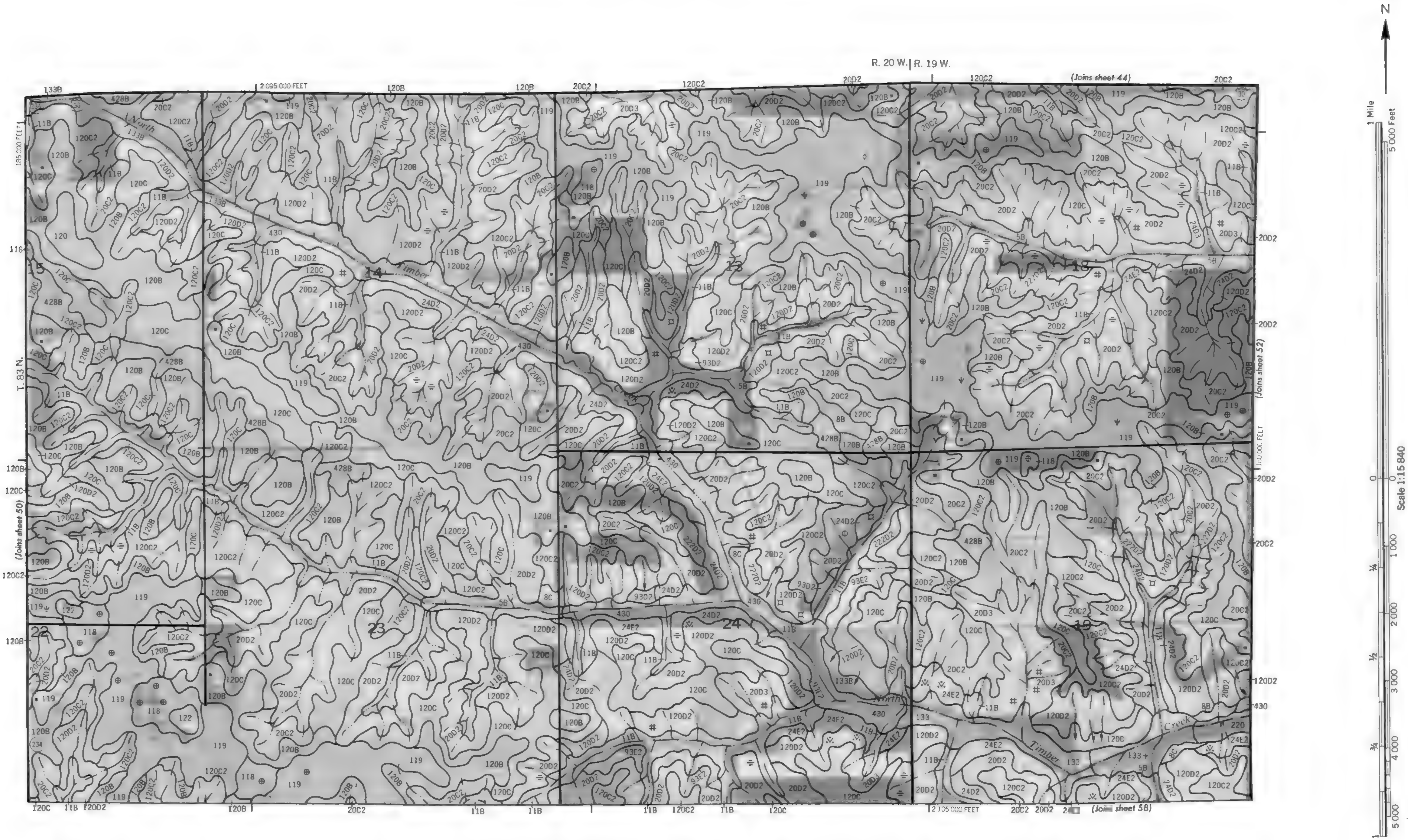
47

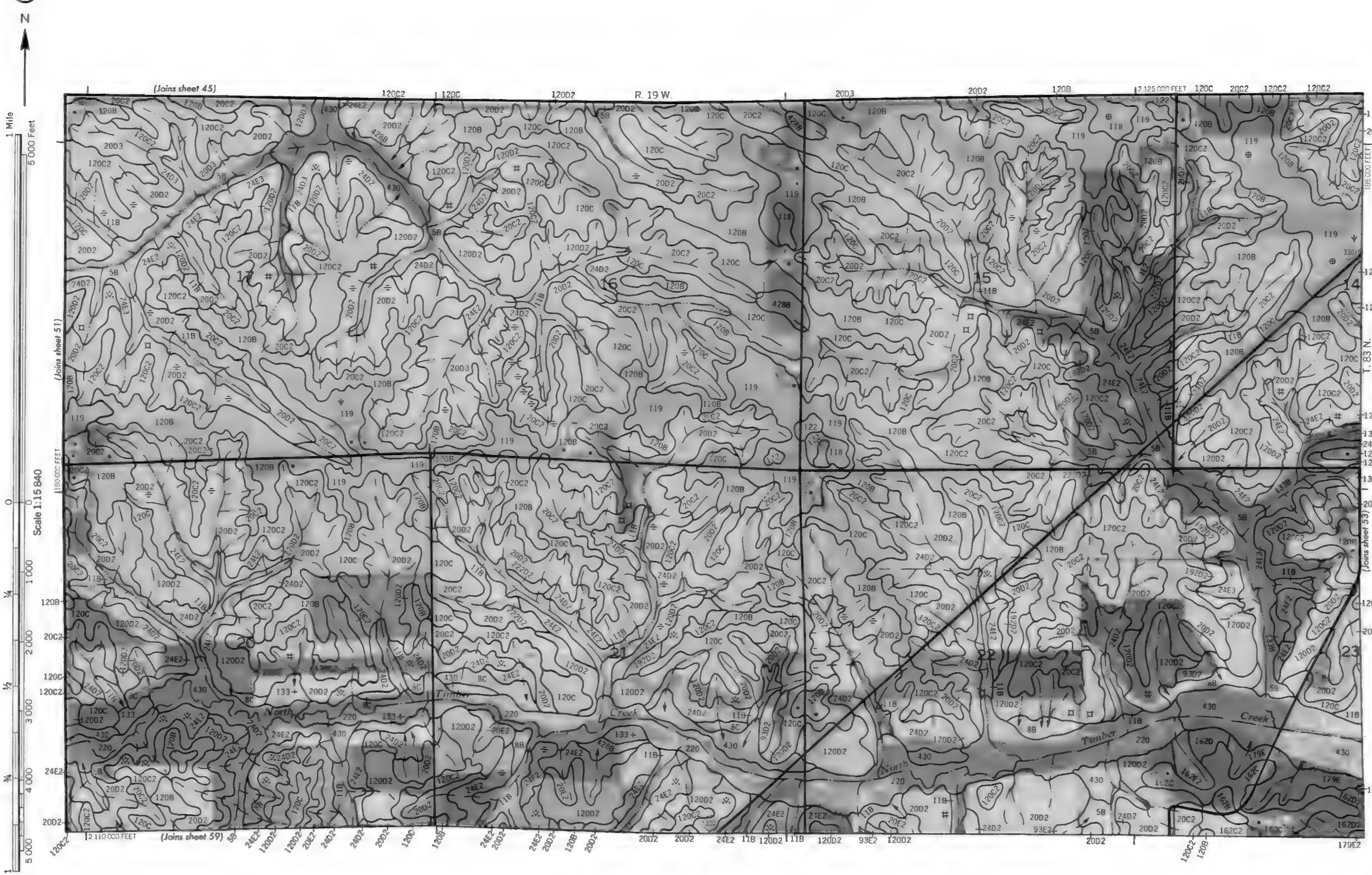

N
(Joins sheet 40)
R. 18 W.
2 150 000 FEET
195 000 FEET
T. 83 N.
MARSHALLTOWN
(Joins sheet 46)
(Joins sheet 48)
190 000 FEET
(Joins sheet 54)
2 165 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840
Creek
Linn
Asher
Creek
CHICAGO AND NORTH WESTERN
CHICAGO MILWAUKEE
PACIFIC

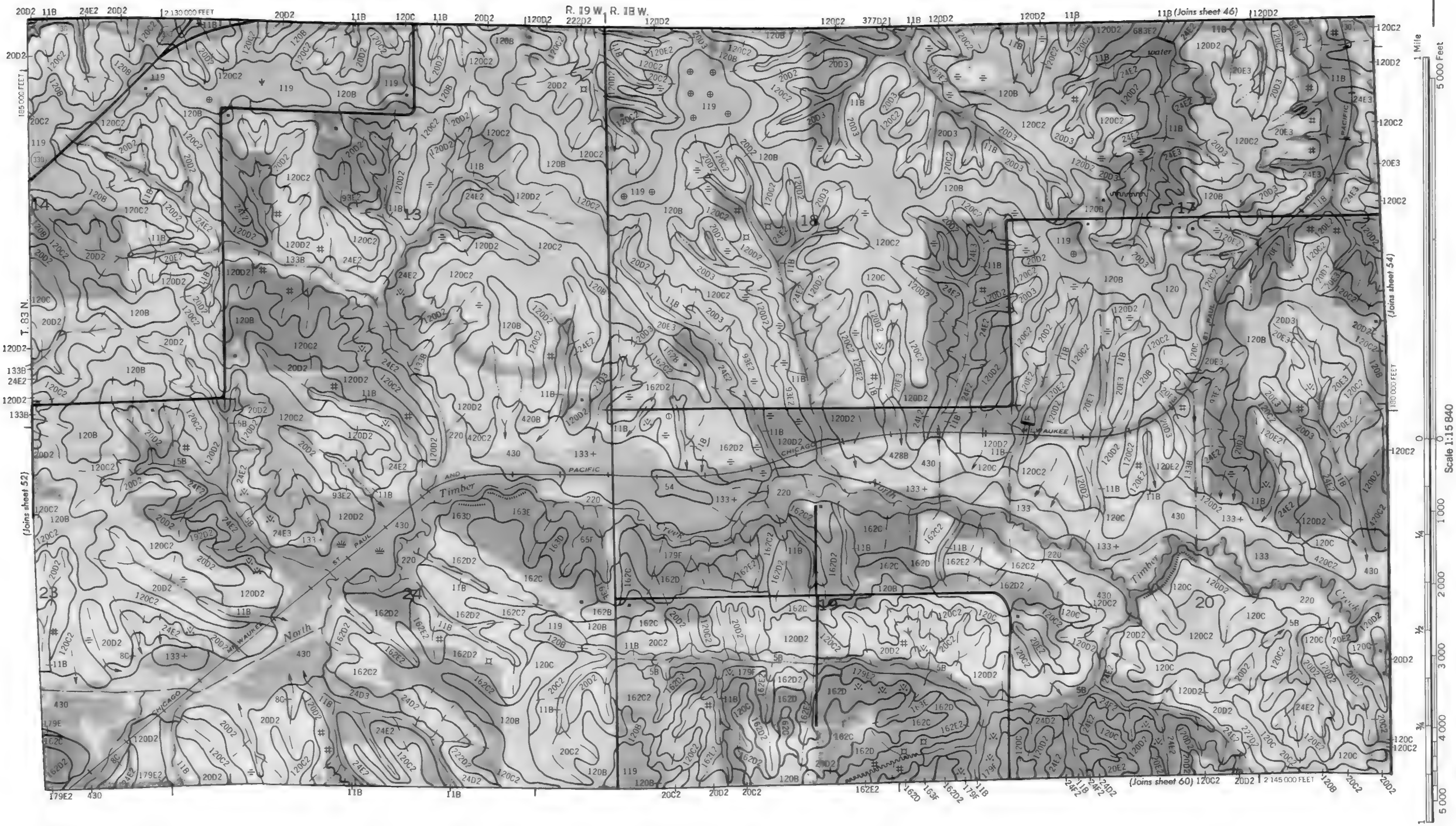

N
MARSHALLTOWN
(Joins sheet 41)
R. 18 W. | R. 17 W.
(Joins sheet 47)
(Joins sheet 49)
(Joins sheet 55)
T. 83 N.
IOWA RIVER
CHICAGO AND NORTH WESTERN
Timber
2 180 000 FEET
2 170 000 FEET
190 000 FEET
195 000 FEET
Scale 1:15 840
1 Mile
5 000 Feet

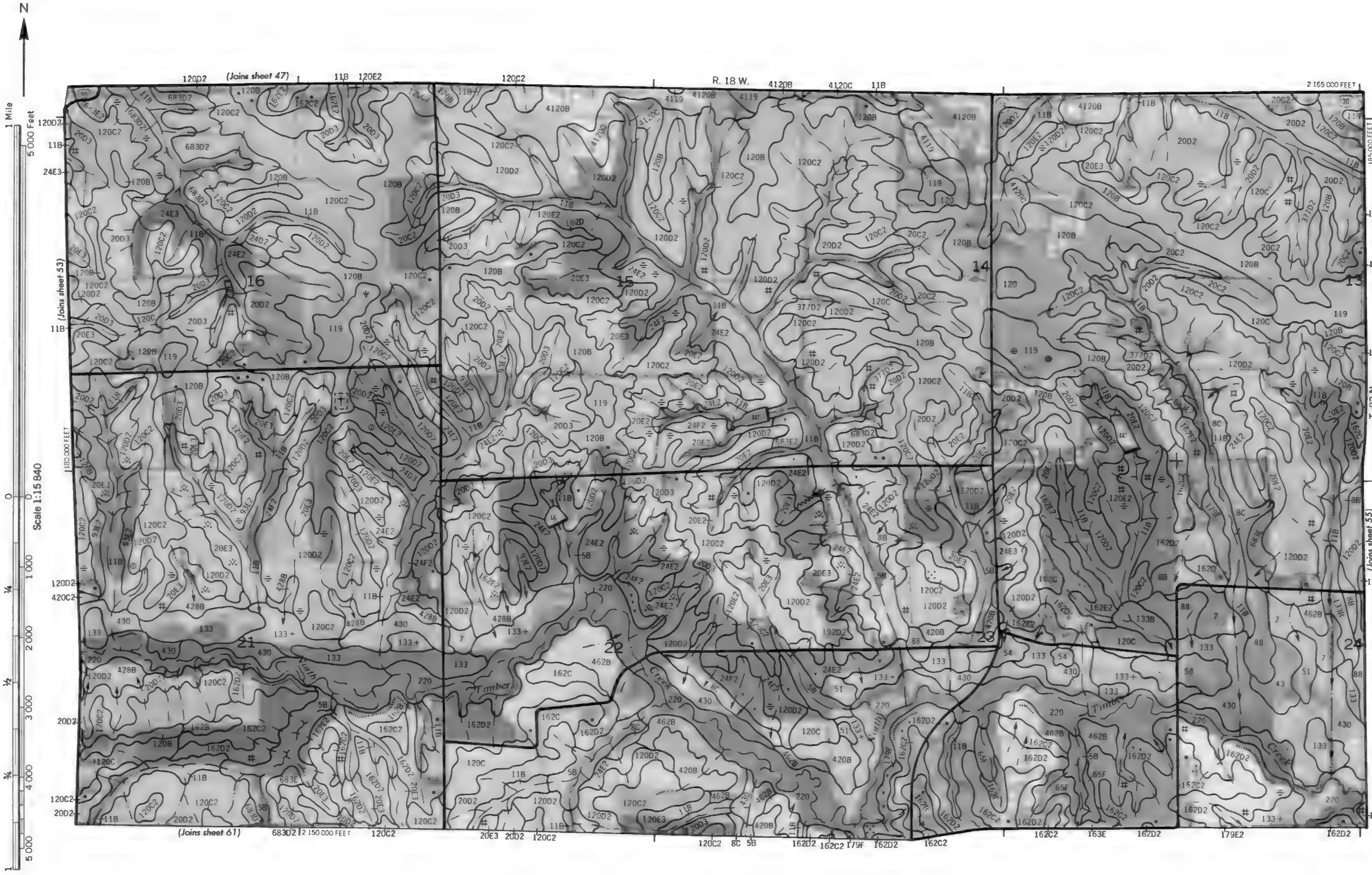

N
R. 17 W.
T. 83 N.
(Joins sheet 42)
(Joins sheet 48)
(Joins sheet 56)
TAMA COUNTY
IOWA
RIVER
Creek
Quarry
MAG HOLLAND ACCESS AREA
Davisons
CHICAGO AND NORTH WESTERN
LeGrand
2 185 000 FEET
2 200 000 FEET
195 000 FEET
190 000 FEET
10
11
12
1 Mile
5000 Feet
Scale 1:15 840

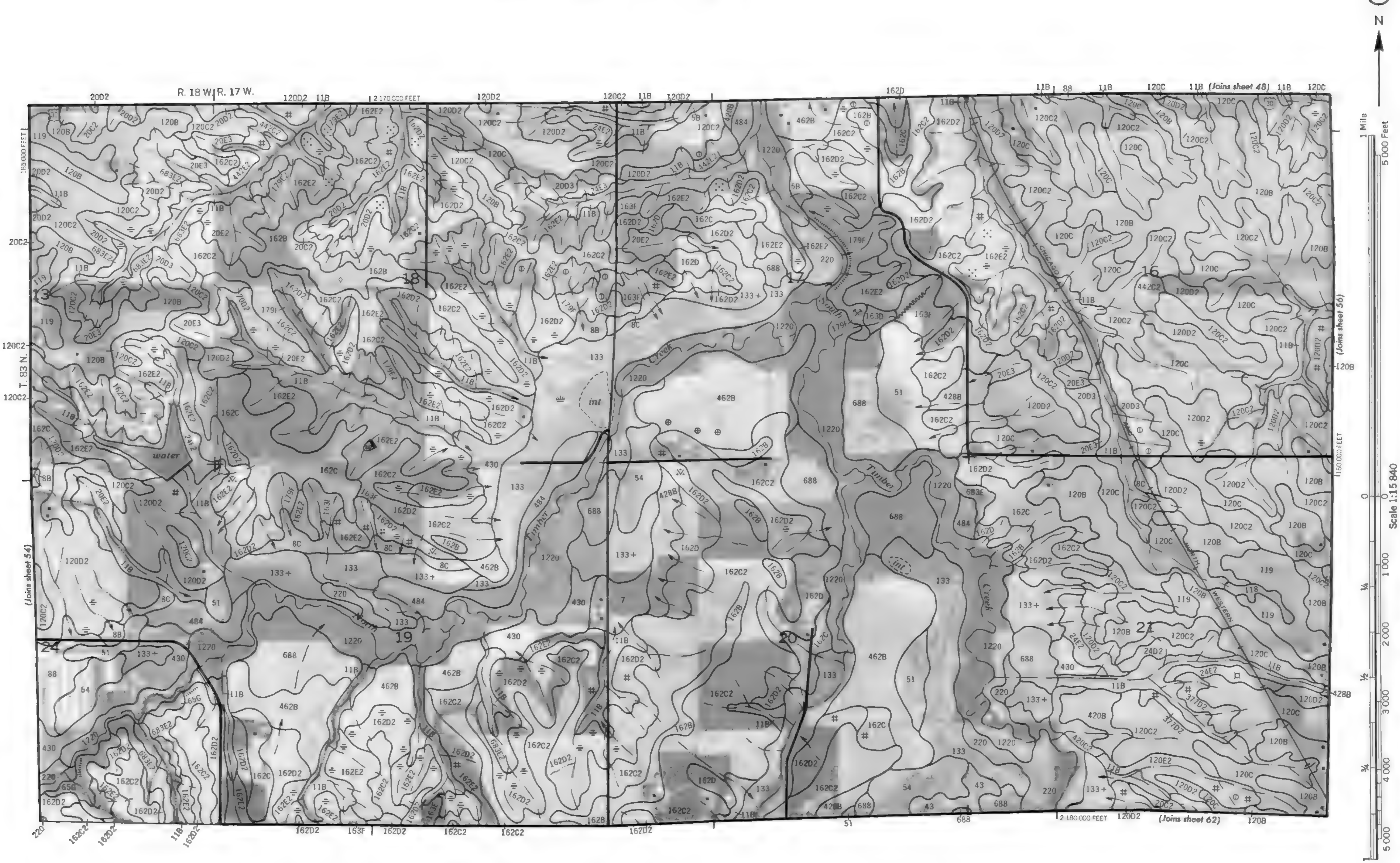

N
(Joins sheet 43)
R. 20 W.
2 090 000 FEET
185 000 FEET
T. 83 N.
(Joins sheet 51)
(Joins sheet 57)
2 075 000 FEET
180 000 FEET
STORY COUNTY
North Skunk River
18
17
16
15
19
20
21
22
1 Mile
5 000 Feet
Scale 1:15 840

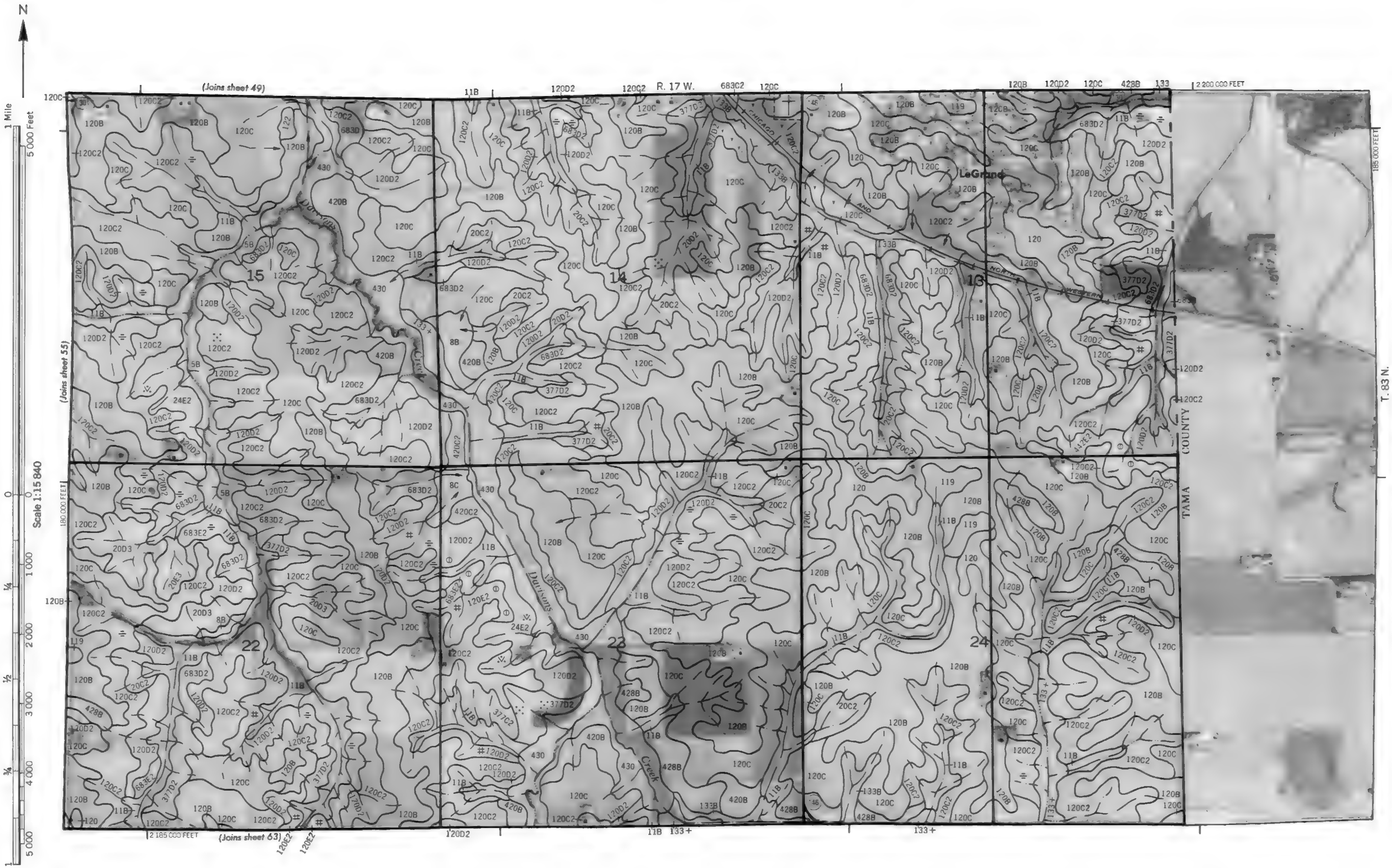

N
R. 20 W. | R. 19 W.
(Joins sheet 44)
(Joins sheet 52)
(Joins sheet 58)
(Joins sheet 50)
T. 83 N.
2 095 000 FEET
2 105 000 FEET
185 000 FEET
150 000 FEET
North Timber Creek
1 Mile
5 000 Feet
Scale 1:15 840
0
1000
2000
3000
4000
5000
¼
½
¾
1


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 45)
(Joins sheet 51)
(Joins sheet 53)
(Joins sheet 59)
R. 19 W.
T. 83 N.
2 125 000 FEET
2 110 000 FEET
185 000 FEET
180 000 FEET
North Timber Creek
Timber Creek


N
R. 19 W. R. 18 W.
T. 83 N.
(Joins sheet 46)
(Joins sheet 54)
(Joins sheet 60)
(Joins sheet 52)
2 130 000 FEET
2 145 000 FEET
185 000 FEET
180 000 FEET
13
14
17
18
19
20
23
24
Timber Creek
North
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
water
1 Mile
5 000 Feet
Scale 1:15 840


N
(Joins sheet 47)
R. 18 W.
T. 83 N.
(Joins sheet 53)
(Joins sheet 55)
(Joins sheet 61)
2 165 000 FEET
185 000 FEET
180 000 FEET
2 150 000 FEET
16
15
14
13
21
22
23
24
North Timber Creek
Timber Creek
Scale 1:15 840
1 Mile
5 000 Feet

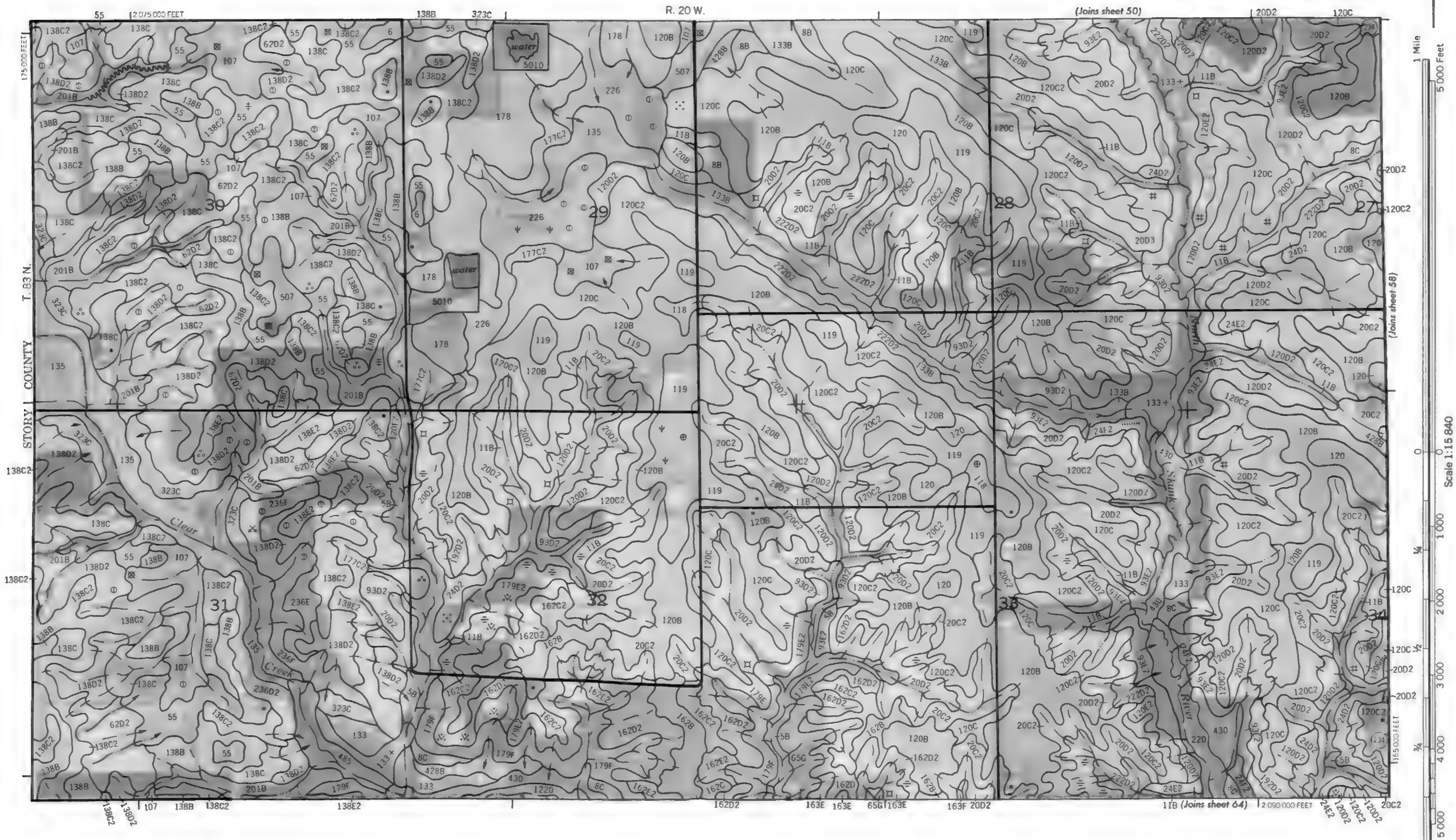

N
R. 18 W.
R. 17 W.
T. 83 N.
2 170 000 FEET
2 180 000 FEET
150 000 FEET
160 000 FEET
(Joins sheet 48)
(Joins sheet 56)
(Joins sheet 54)
(Joins sheet 62)
South Timber Creek
North Timber Creek
Timber Creek
CHICAGO AND NORTH WESTERN
water
int
13
16
17
18
19
20
21
24
1 Mile
5 000 Feet
Scale 1:15 840

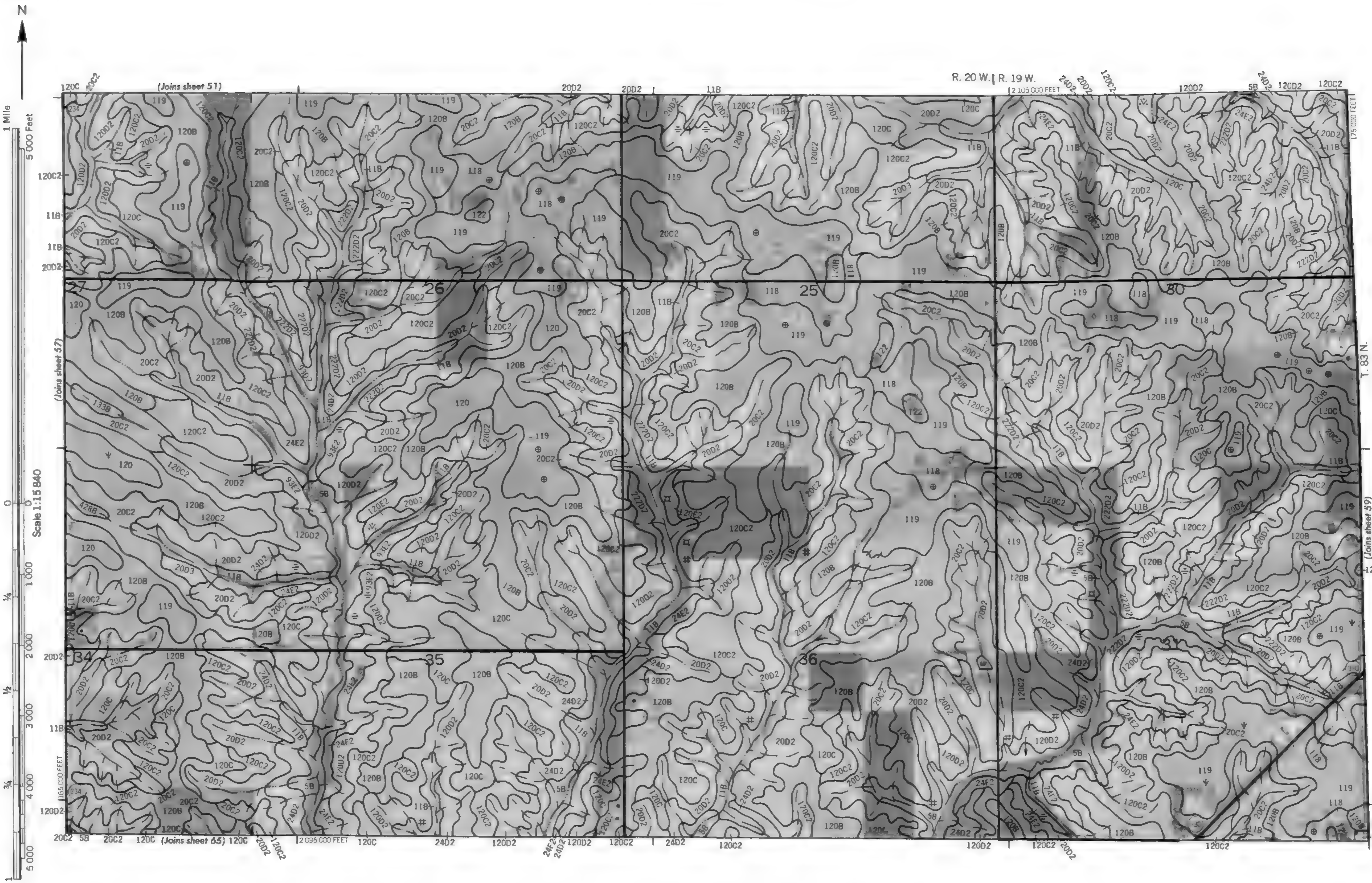

N
(Joins sheet 49)
R. 17 W.
(Joins sheet 55)
(Joins sheet 63)
T. 83 N.
TAMA COUNTY
LeGrand
CHICAGO AND NORTH WESTERN
Creek
15
14
13
22
23
24
2 200 000 FEET
185 000 FEET
180 000 FEET
2 185 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840

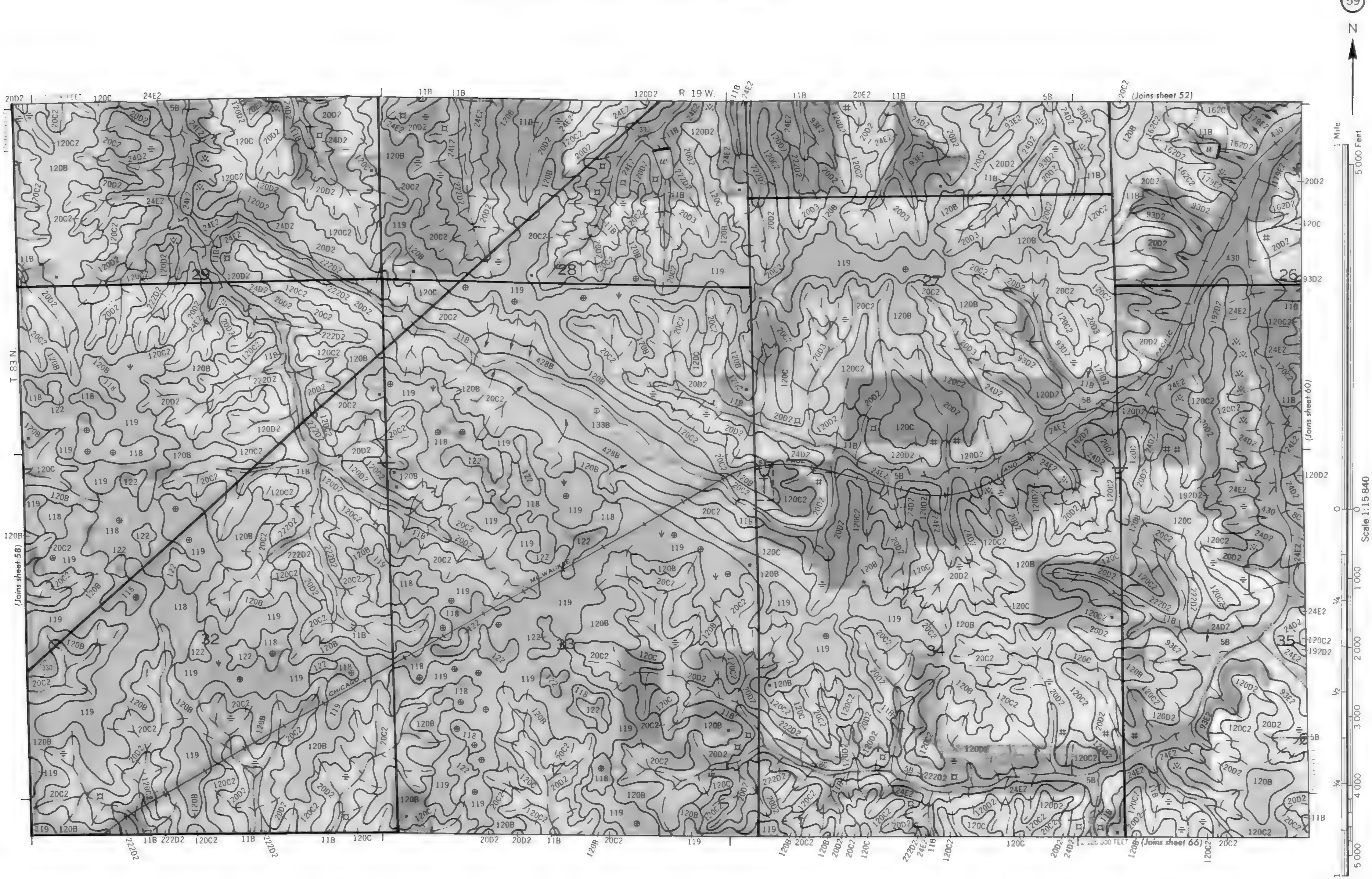
MARSHALL COUNTY, IOWA — SHEET NUMBER 57

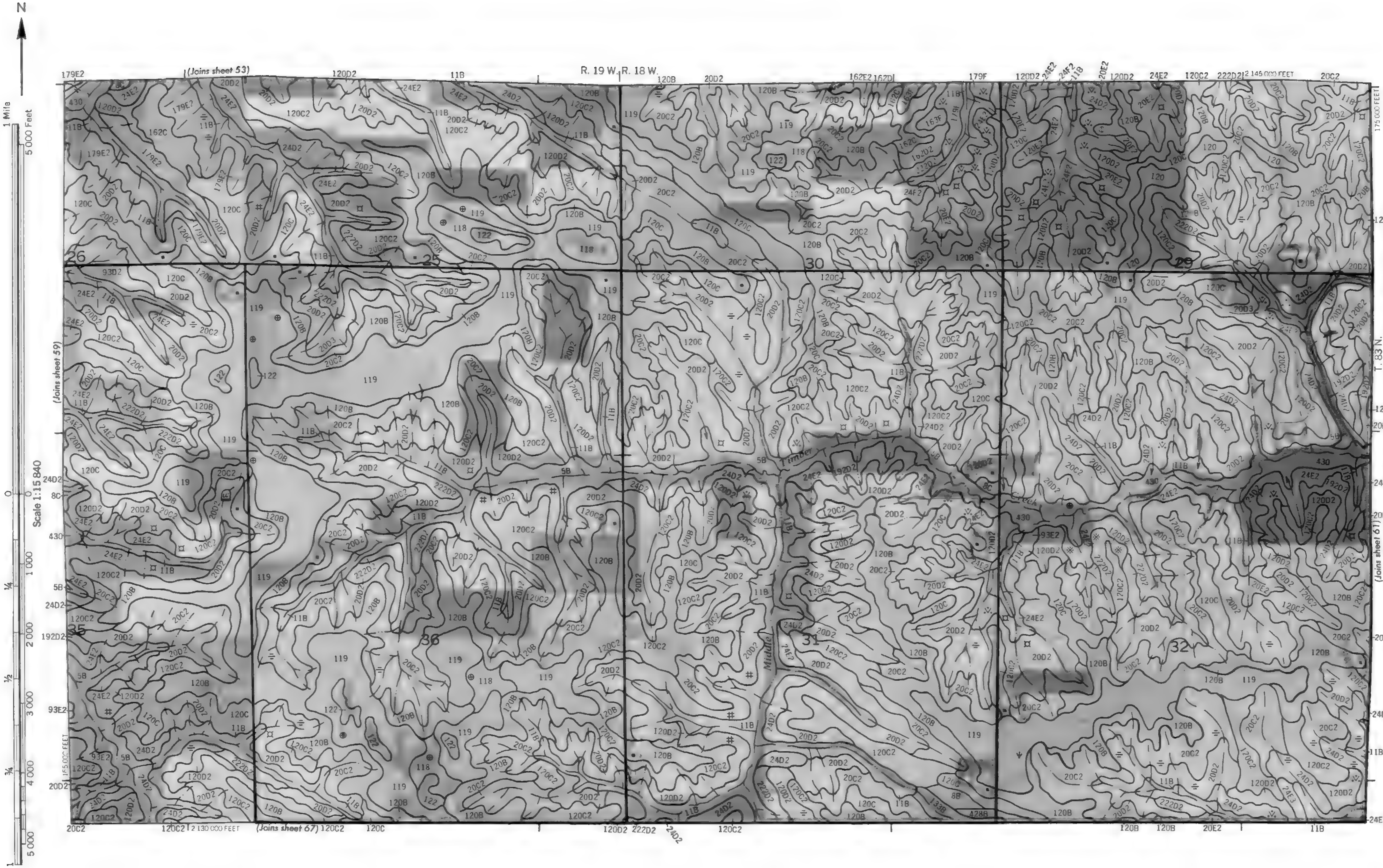
57

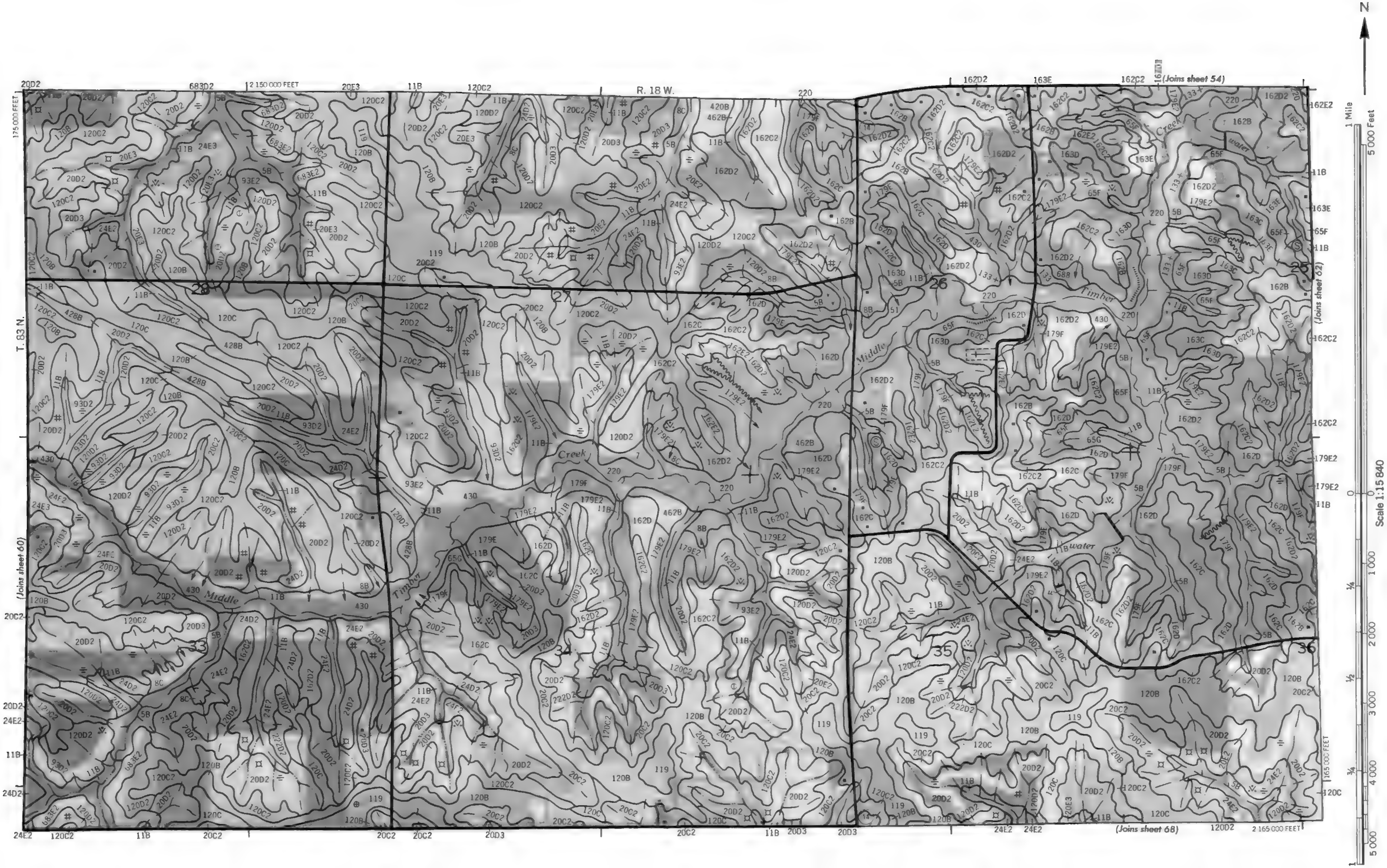
N

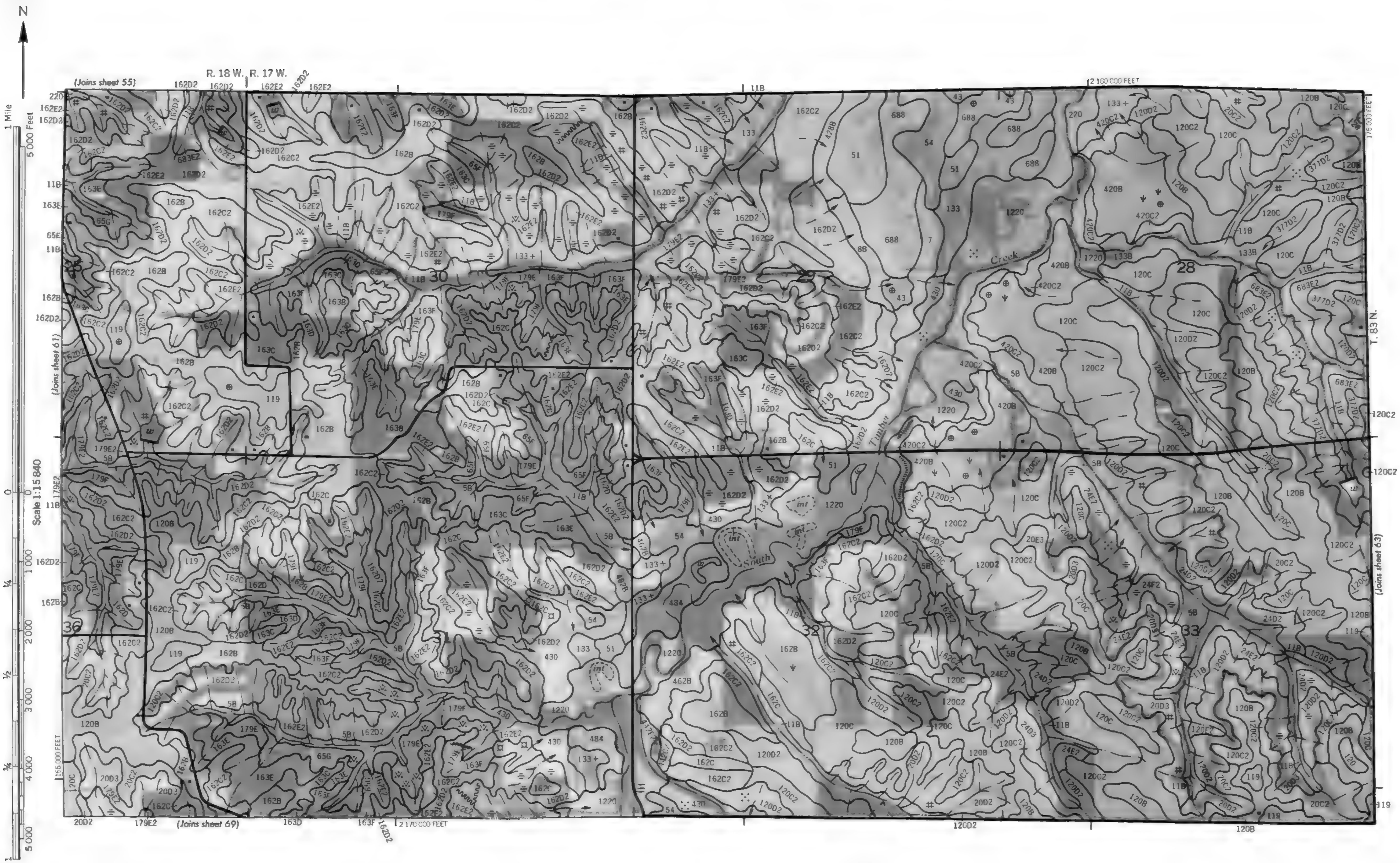


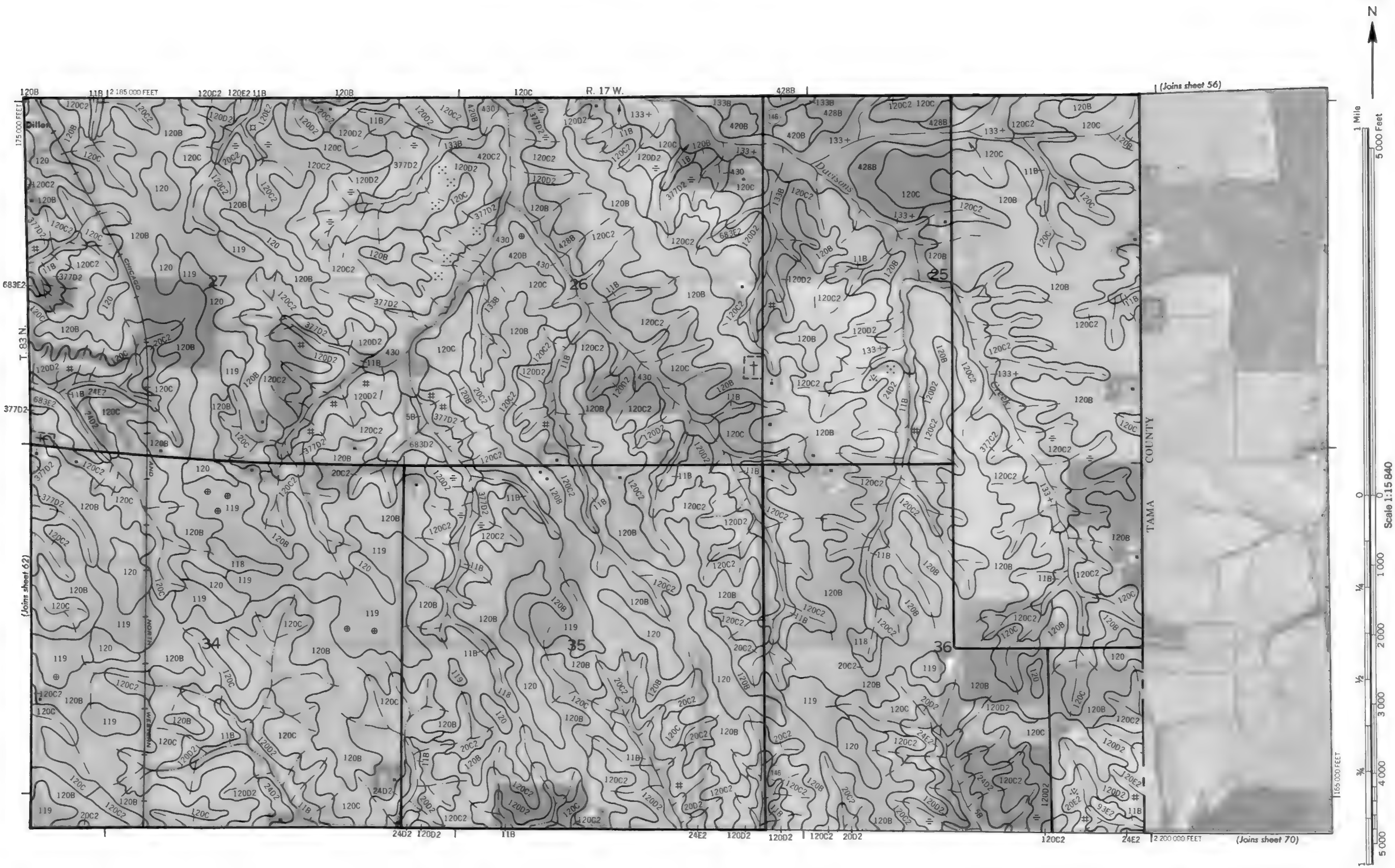

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 51)
(Joins sheet 57)
(Joins sheet 59)
(Joins sheet 65)
R. 20 W. | R. 19 W.
T. 83 N.
2 105 000 FEET
175 000 FEET
2 095 000 FEET
165 000 FEET
26
25
27
30
34
35
36
31

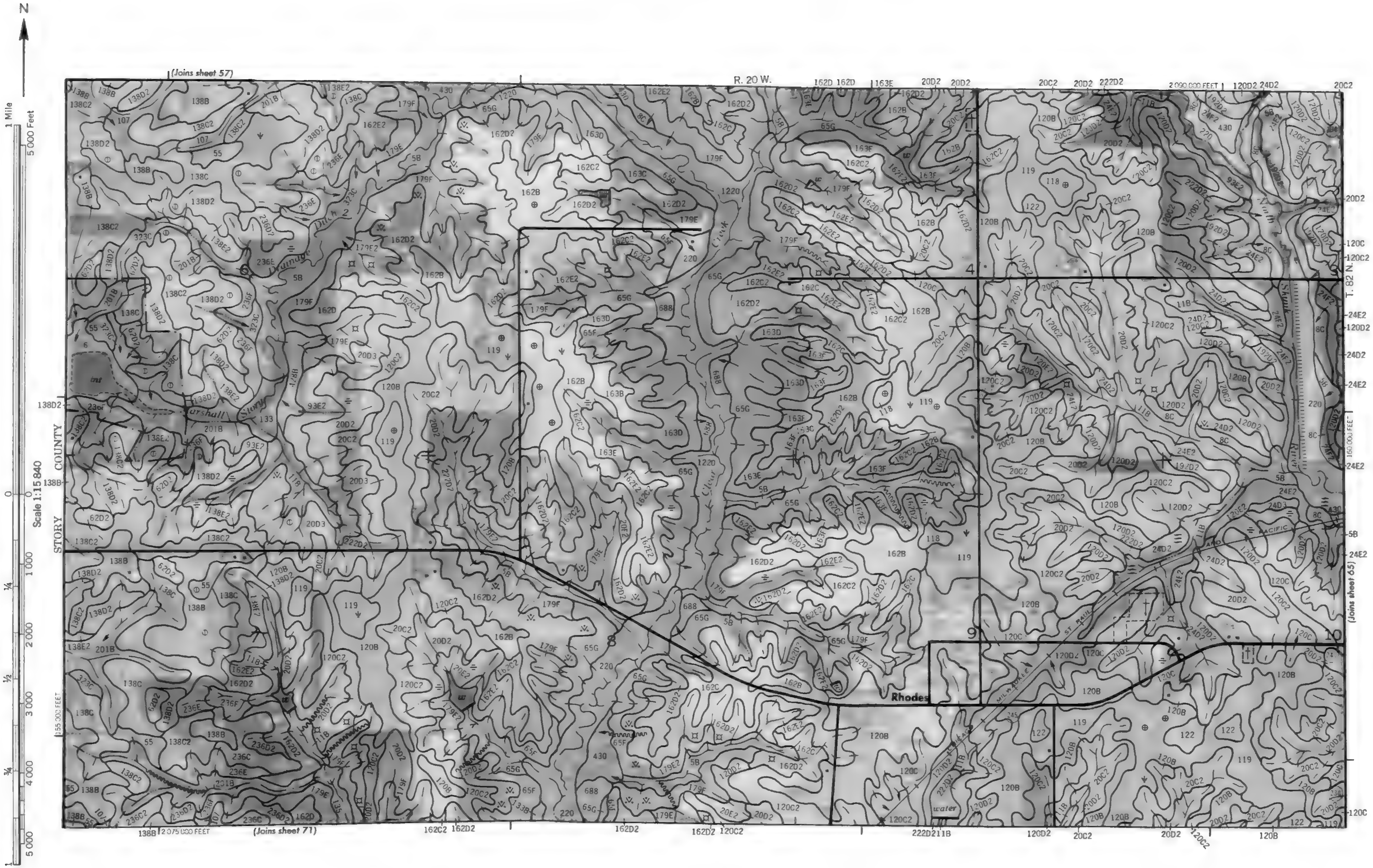

N
(Joins sheet 52)
(Joins sheet 60)
(Joins sheet 66)
(Joins sheet 58)
R 19 W.
T 83 N.
29
28
27
26
32
33
34
35
MILWAUKEE
CHICAGO
PACIFIC
AND
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000

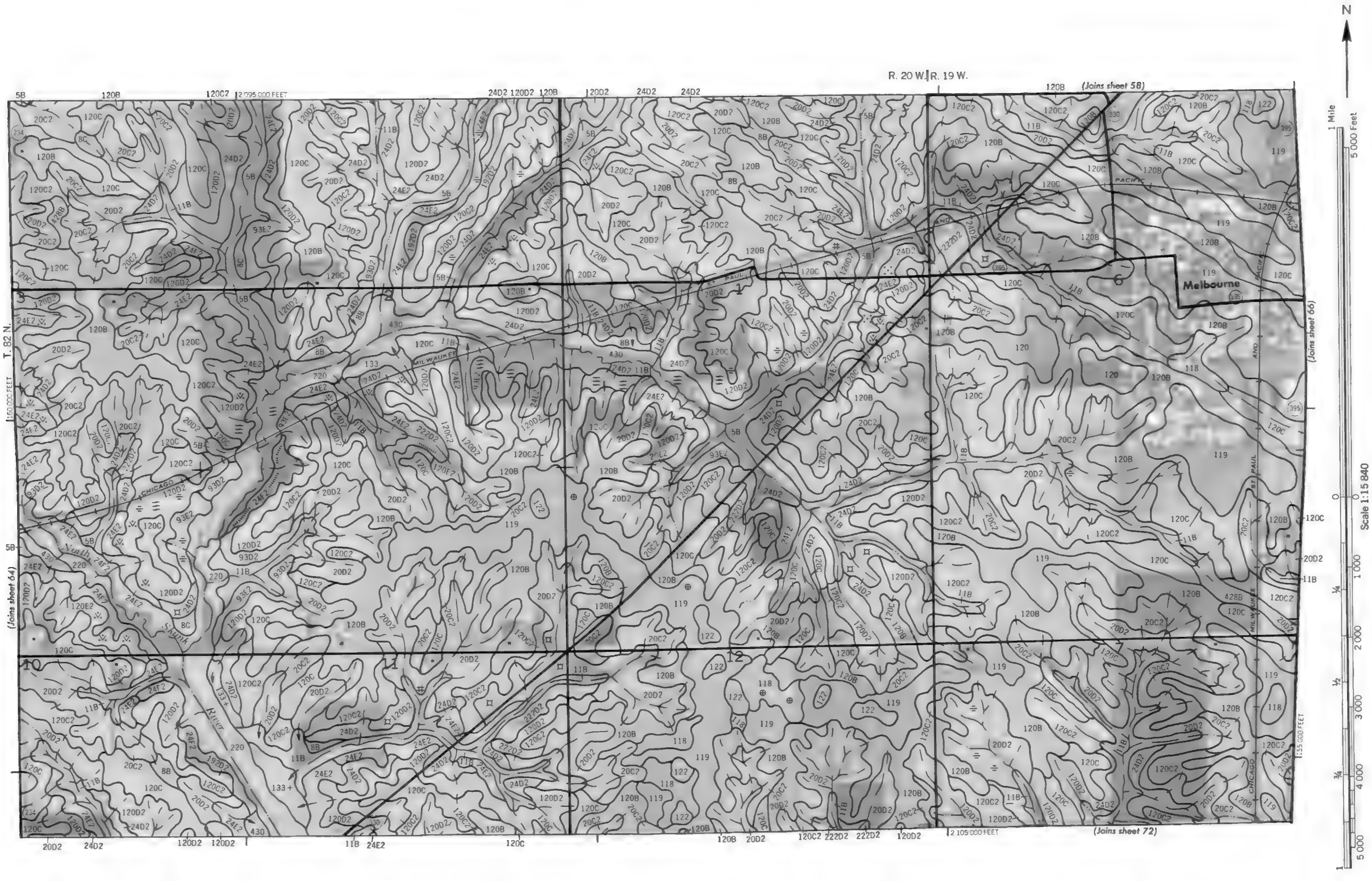

N
(Joins sheet 53)
R. 19 W. R. 18 W.
(Joins sheet 59)
(Joins sheet 61)
(Joins sheet 67)
T. 83 N.
Scale 1:15 840
1 Mile
5 000 Feet
2 145 000 FEET
2 130 000 FEET
175 000 FEET
155 000 FEET
Timber
Creek
Middle
25
26
29
30
31
32
35
36

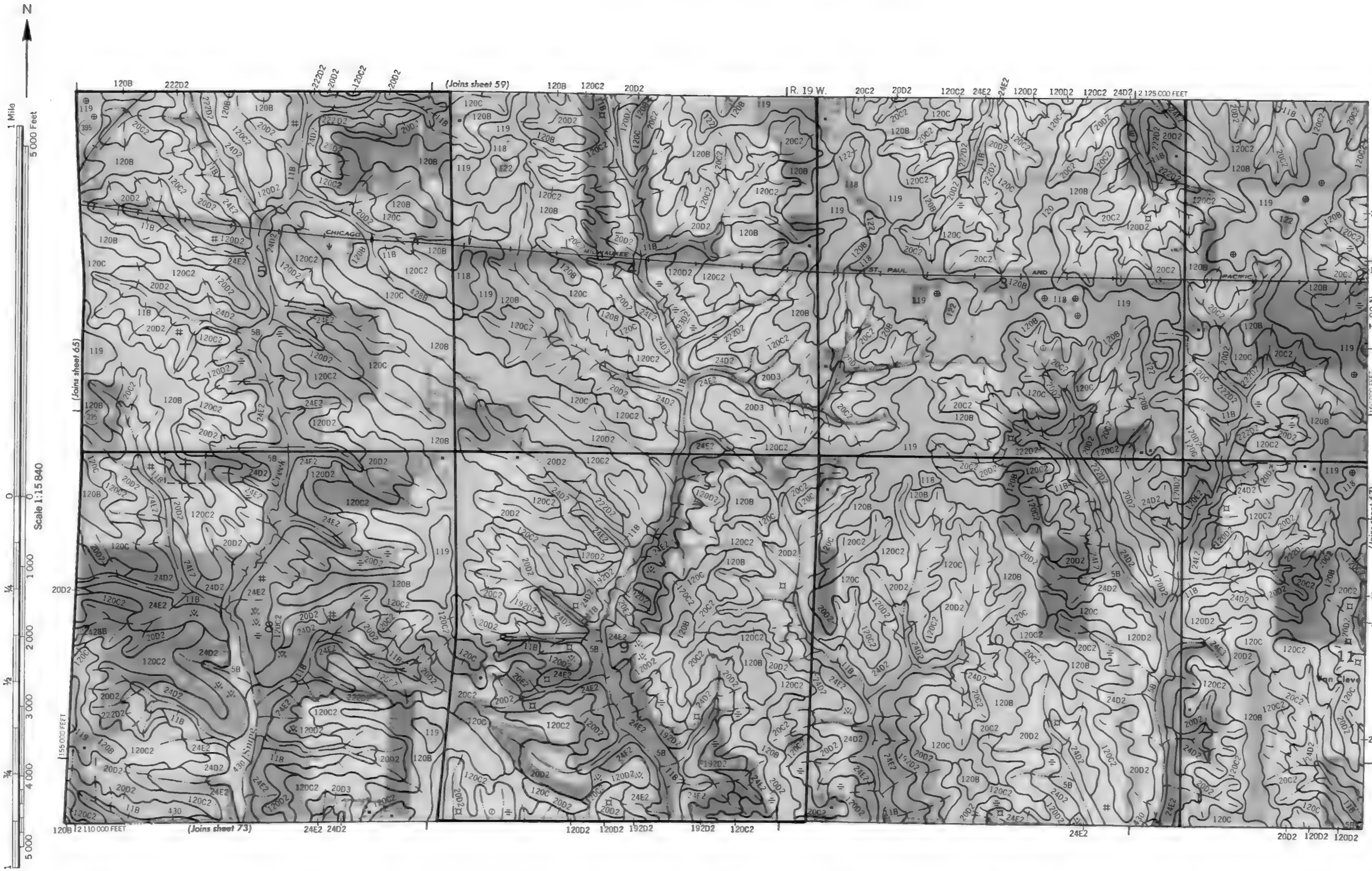

N
R. 18 W.
T. 83 N.
(Joins sheet 54)
(Joins sheet 62)
(Joins sheet 68)
(Joins sheet 60)
2 150 000 FEET
2 165 000 FEET
175 000 FEET
165 000 FEET
Middle
Timber
Creek
water
28
27
26
25
33
34
35
36
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000

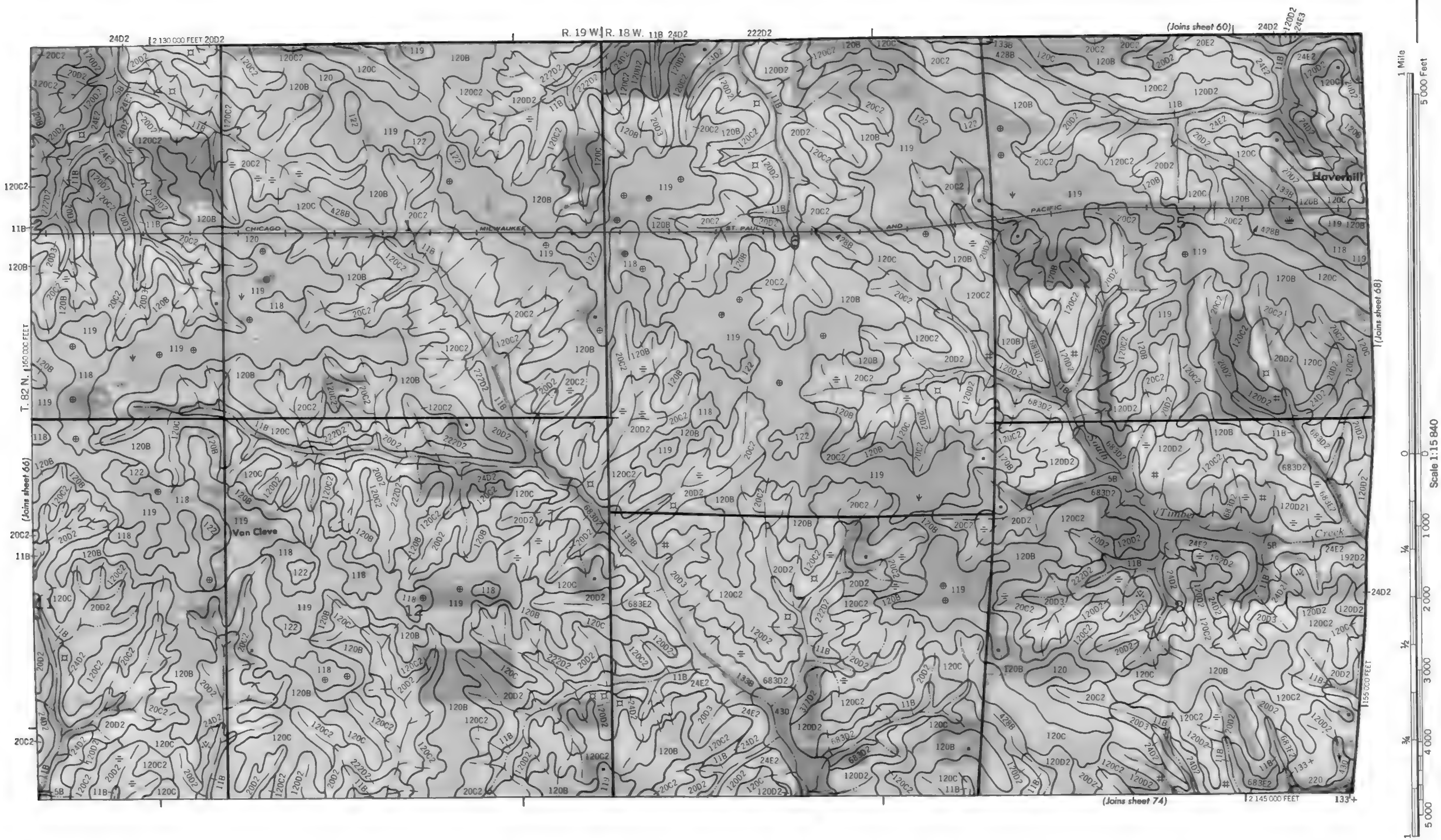

N
(Joins sheet 55)
R. 18 W.
R. 17 W.
2 180 000 FEET
T. 83 N.
(Joins sheet 61)
(Joins sheet 63)
(Joins sheet 69)
2 170 000 FEET
165 000 FEET
Scale 1:15 840
1 Mile
5 000 Feet
30
29
28
31
32
33
36
Creek
Timber
South


N
R. 17 W.
T. 83 N.
2 185 000 FEET
175 000 FEET
165 000 FEET
2 200 000 FEET
(Joins sheet 56)
(Joins sheet 62)
(Joins sheet 70)
Dillon
CHICAGO
AND
NORTH
WESTERN
Davisons
Creek
TAMA
COUNTY
27
26
25
34
35
36
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1000
2000
3000
4000
5000

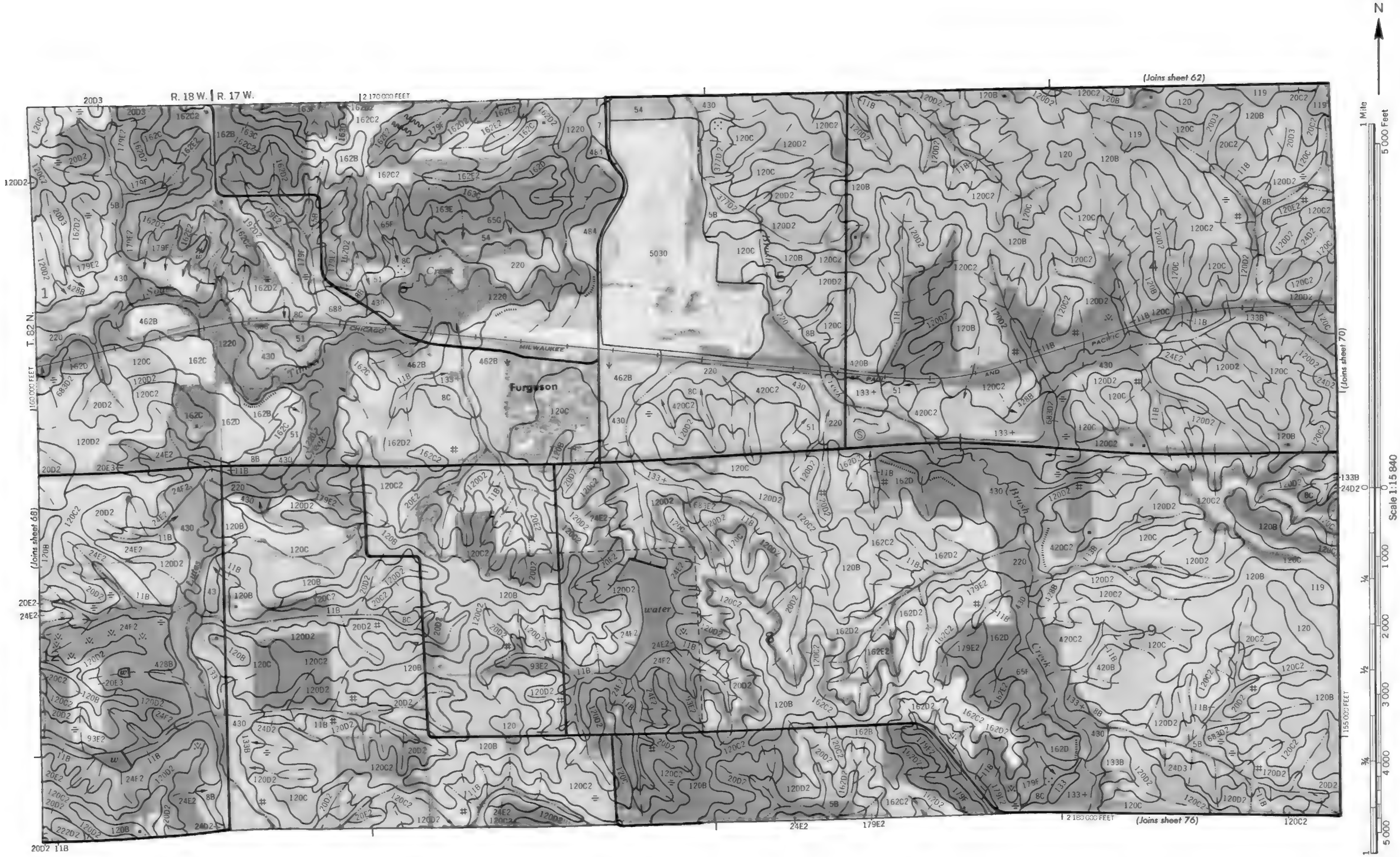

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 57)
R. 20 W.
2 090 000 FEET
T. 82 N.
160 000 FEET
(Joins sheet 65)
(Joins sheet 71)
2 075 000 FEET
155 000 FEET
STORY COUNTY
Drainage Ditch 2
Marshall Story
Clear Creek
Skunk River
Rhodes
MILWAUKEE ST PAUL AND PACIFIC
water

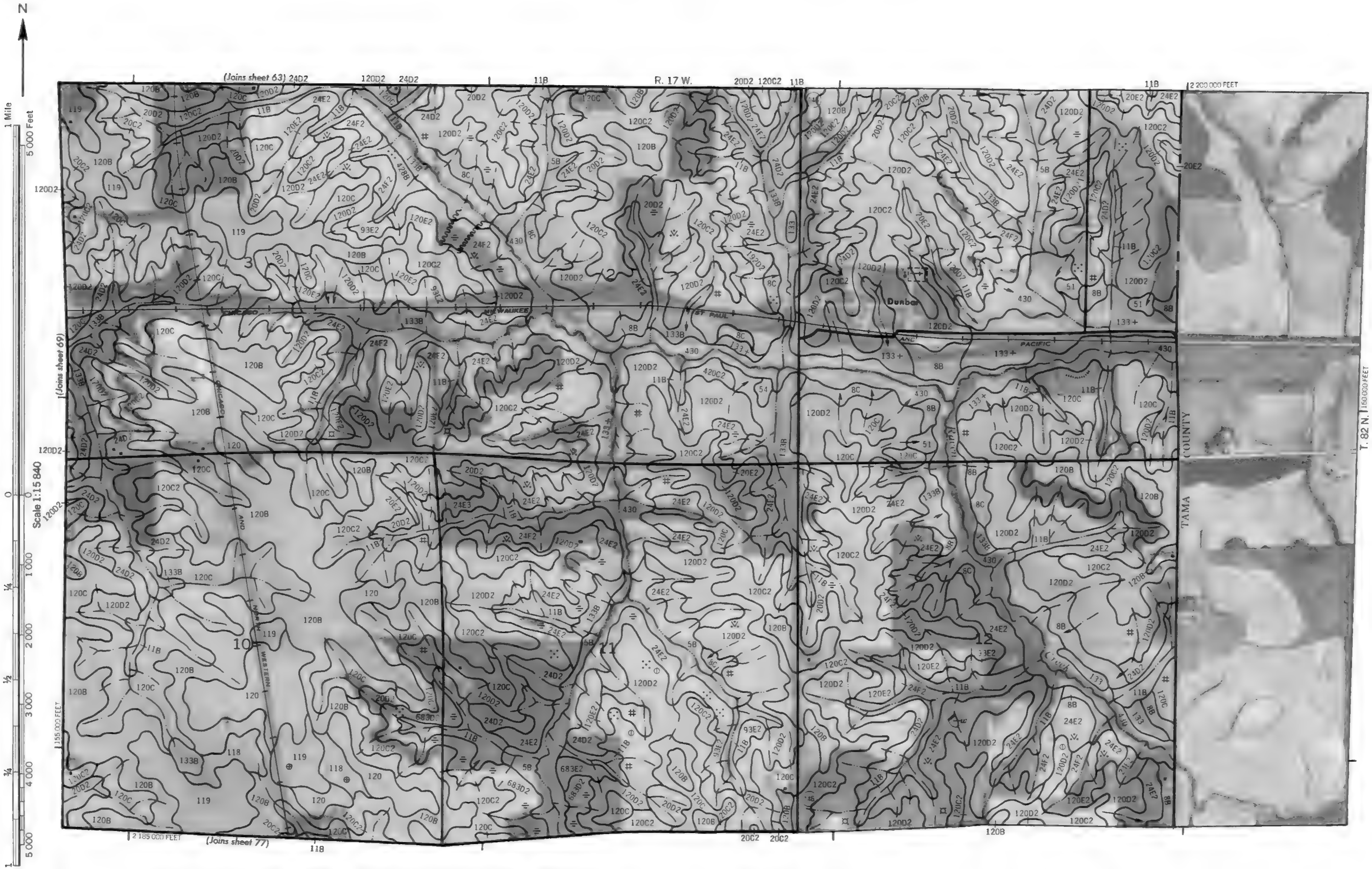

N
R. 20 W. R. 19 W.
(Joins sheet 58)
(Joins sheet 66)
(Joins sheet 72)
(Joins sheet 64)
T. 82 N.
Melbourne
CHICAGO
MILWAUKEE
ST. PAUL
AND
PACIFIC
Skunk
River
Youth
2 095 000 FEET
2 105 000 FEET
160 000 FEET
155 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840

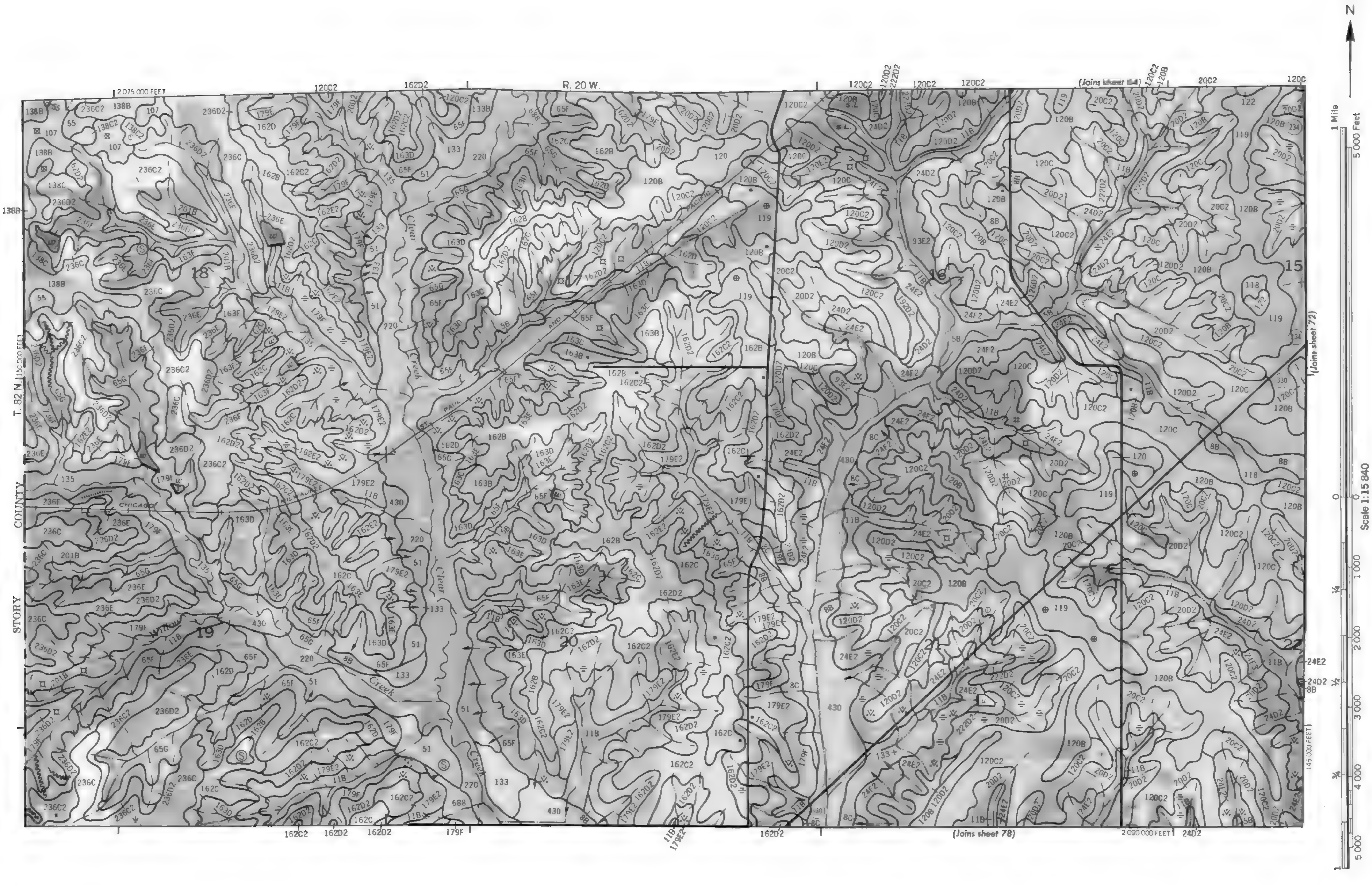

66
N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 59)
(Joins sheet 65)
(Joins sheet 67)
(Joins sheet 73)
R. 19 W.
T. 82 N.
2 125 000 FEET
2 110 000 FEET
155 000 FEET
160 000 FEET
CHICAGO
MILWAUKEE
ST. PAUL
AND
PACIFIC
Creek
Snipe
Van Cleve


N
(Joins sheet 60)
R. 19 W. | R. 18 W.
2 130 000 FEET
T. 82 N.
150 000 FEET
(Joins sheet 66)
(Joins sheet 68)
(Joins sheet 74)
2 145 000 FEET
155 000 FEET
Haverhill
Van Cleve
CHICAGO
MILWAUKEE
ST. PAUL
AND
PACIFIC
South
Timber
Creek
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
1/4
1/2
3/4
1

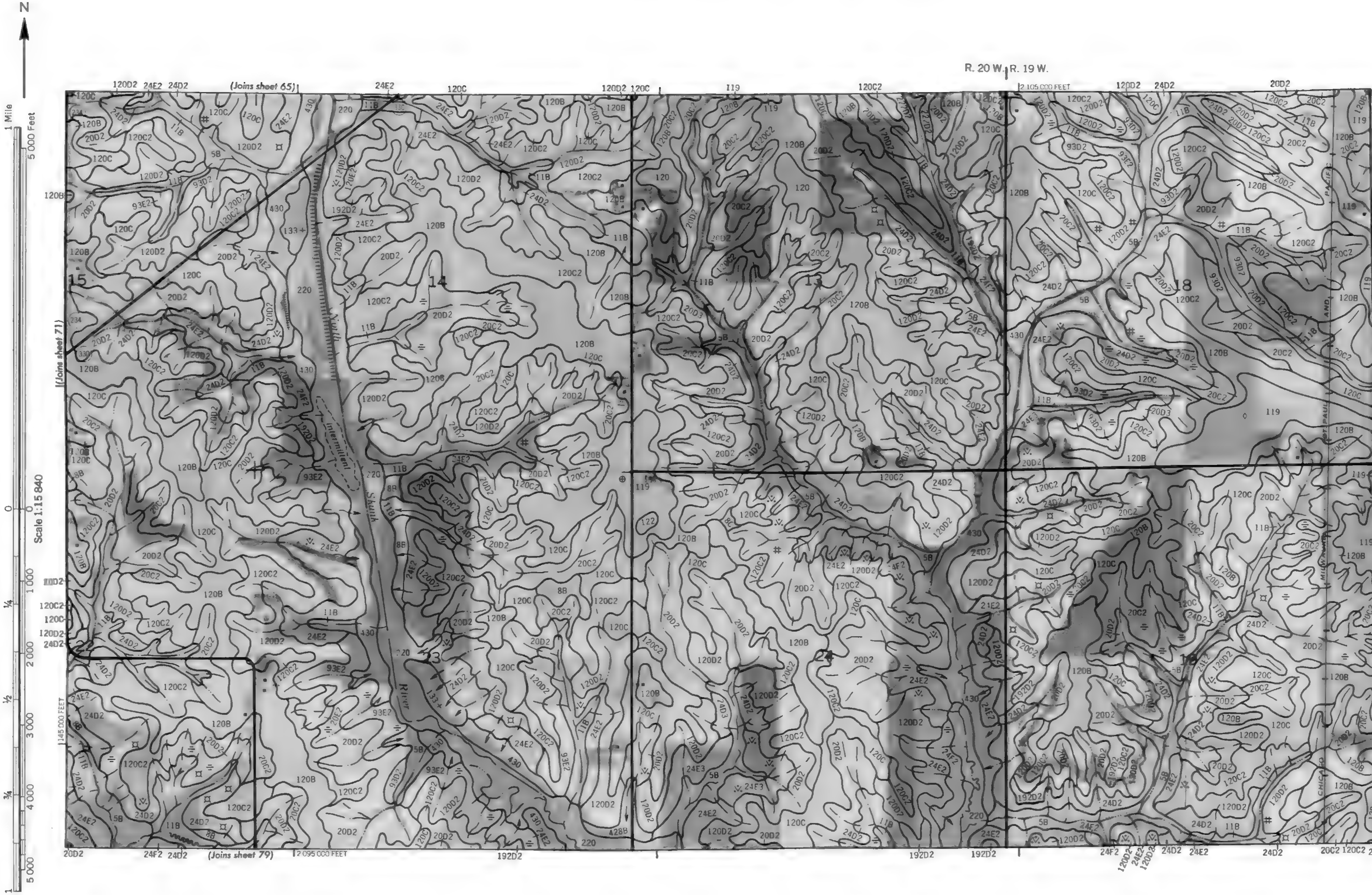

N
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾
(Joins sheet 61)
R. 18 W.
2 165 000 FEET
(Joins sheet 67)
(Joins sheet 69)
T. 82 N.
160 000 FEET
155 000 FEET
(Joins sheet 75)
2 150 000 FEET
Haverhill
CHICAGO
MILWAUKEE
ST. PAUL
AND
PACIFIC
Timber
Creek
South
Timber
Creek
South
Creek
Timber

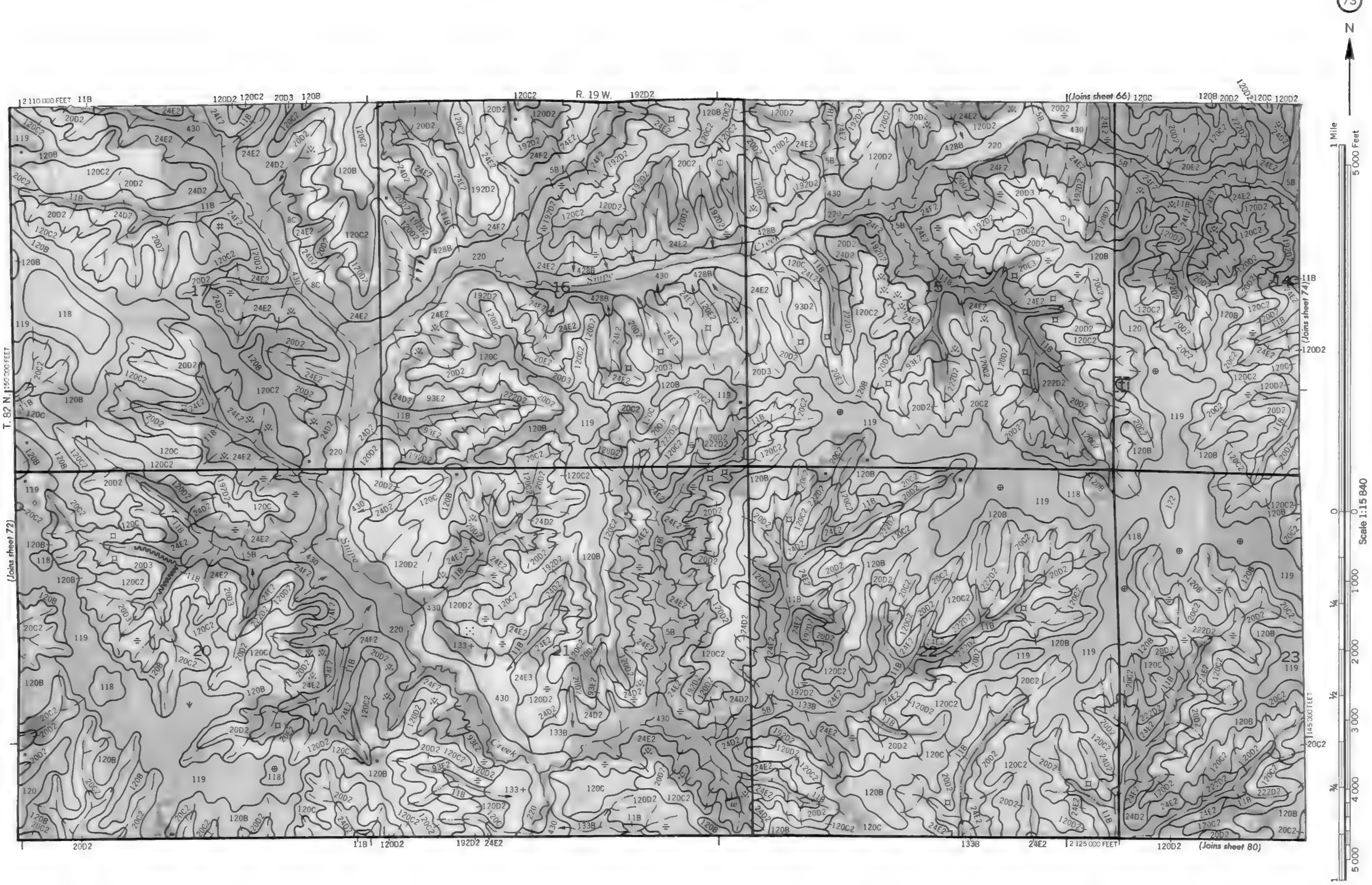

N
(Joins sheet 62)
(Joins sheet 70)
(Joins sheet 76)
(Joins sheet 68)
R. 18 W. | R. 17 W.
T. 82 N.
2 170 000 FEET
2 180 000 FEET
160 000 FEET
155 000 FEET
Furguson
CHICAGO
MILWAUKEE
ST. PAUL
AND
PACIFIC
Brush Creek
Timber Creek
Little Creek
water
1 Mile
5 000 Feet
Scale 1:15 840


N
(Joins sheet 63)
R. 17 W.
(Joins sheet 69)
(Joins sheet 77)
T. 82 N.
TAMA COUNTY
Dunbar
CHICAGO
MILWAUKEE
ST PAUL
PACIFIC
CHICAGO AND NORTH WESTERN
Scale 1:15 840
1 Mile
5 000 Feet
2 200 000 FEET
2 185 000 FEET
155 000 FEET
160 000 FEET

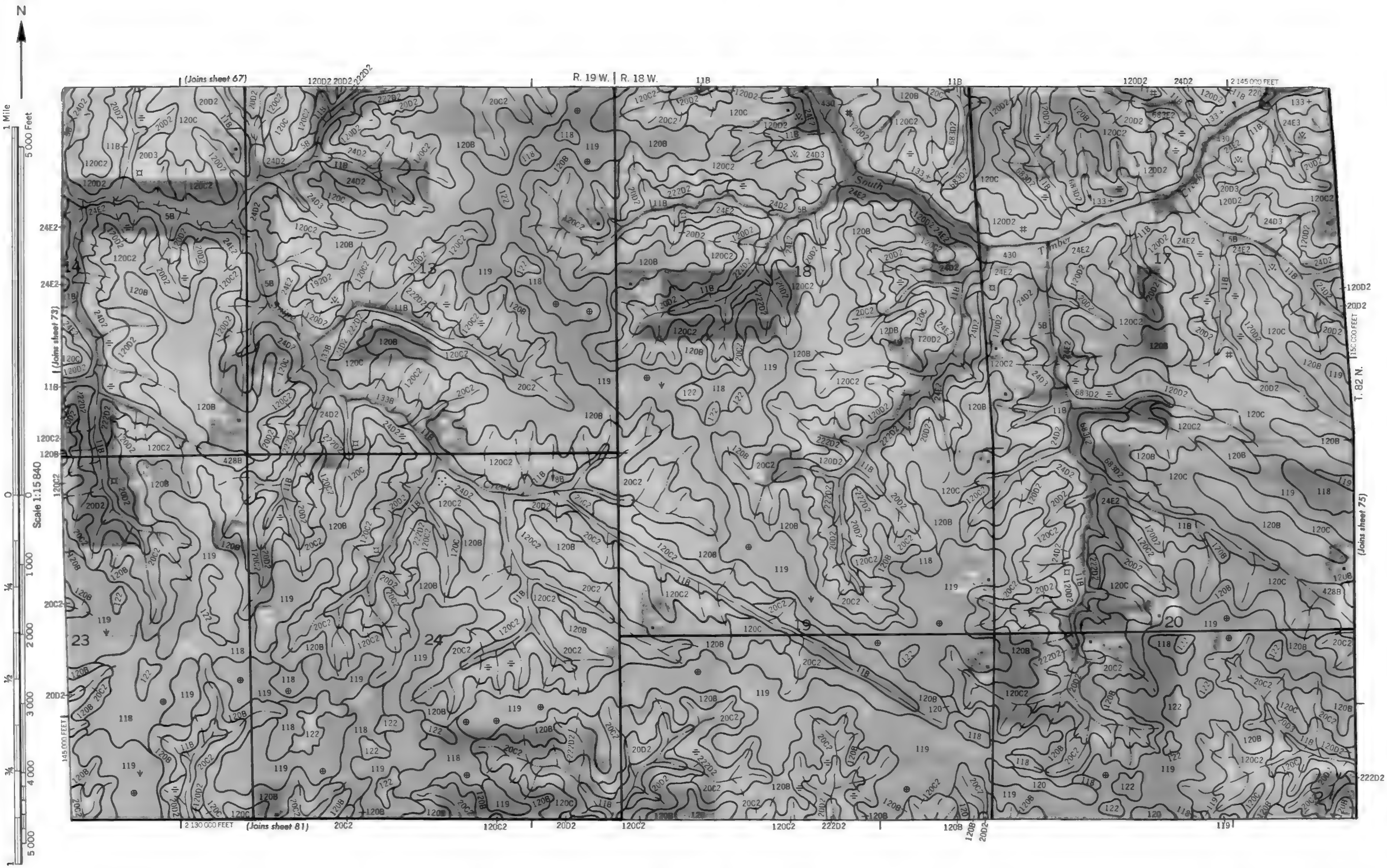

N
R. 20 W.
T. 82 N.
STORY COUNTY
2 075 000 FEET
150 000 FEET
145 000 FEET
2 090 000 FEET
(Joins sheet 72)
(Joins sheet 78)
Clear Creek
Willow Creek
CHICAGO MILWAUKEE ST. PAUL AND PACIFIC
18
17
16
15
19
20
21
22
1 Mile
5 000 Feet
Scale 1:15 840

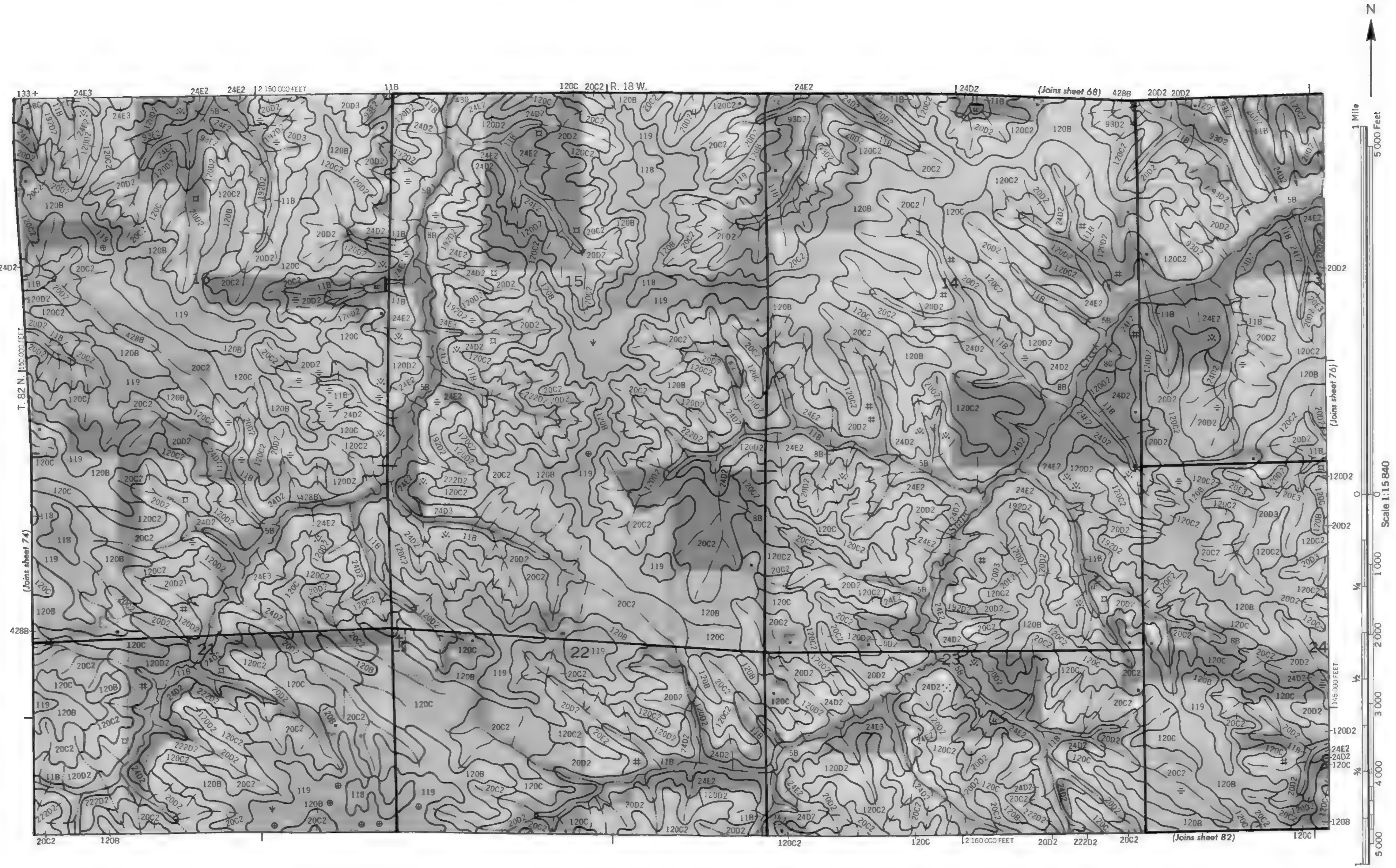
MARSHALL COUNTY, IOWA — SHEET NUMBER 72

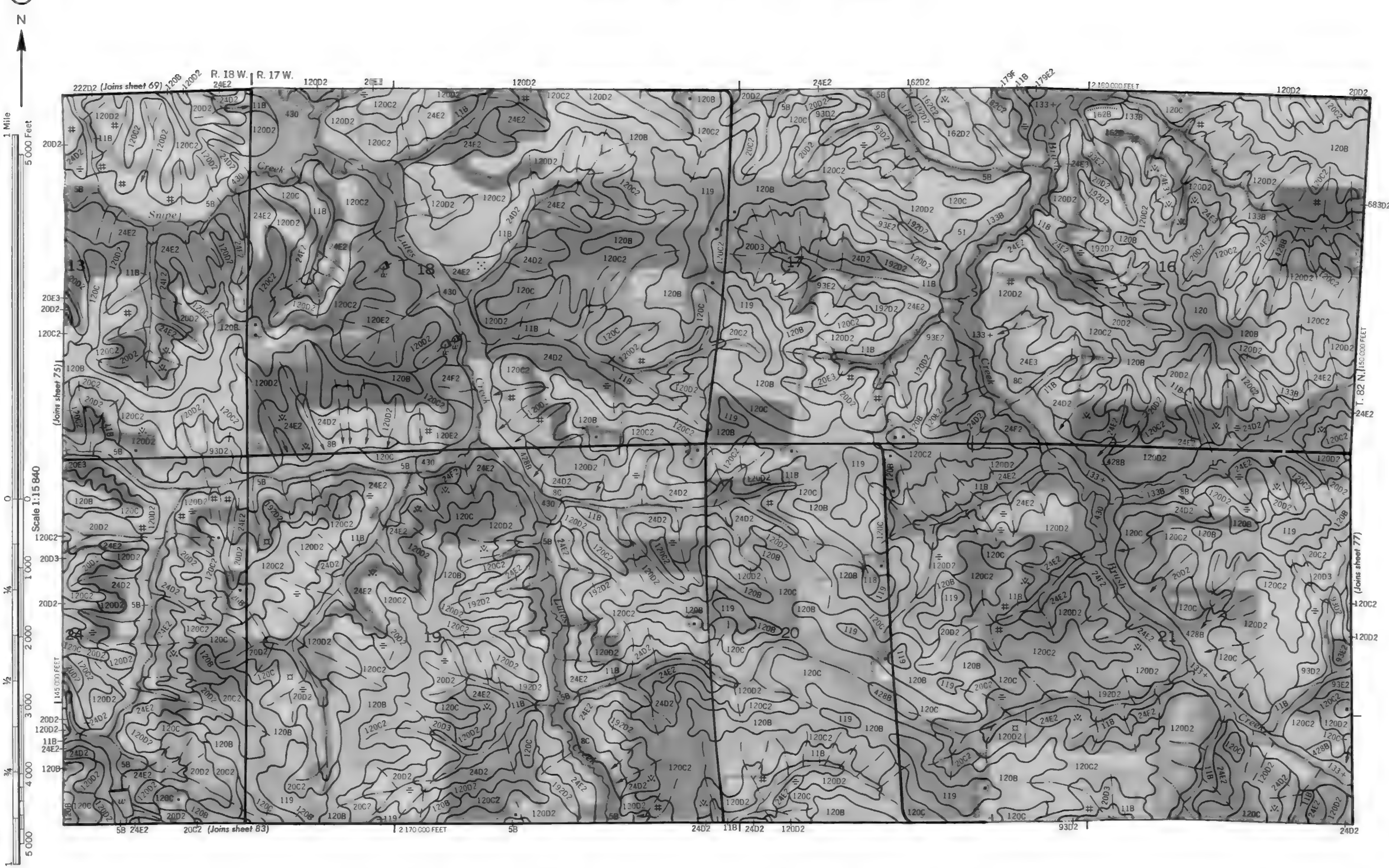


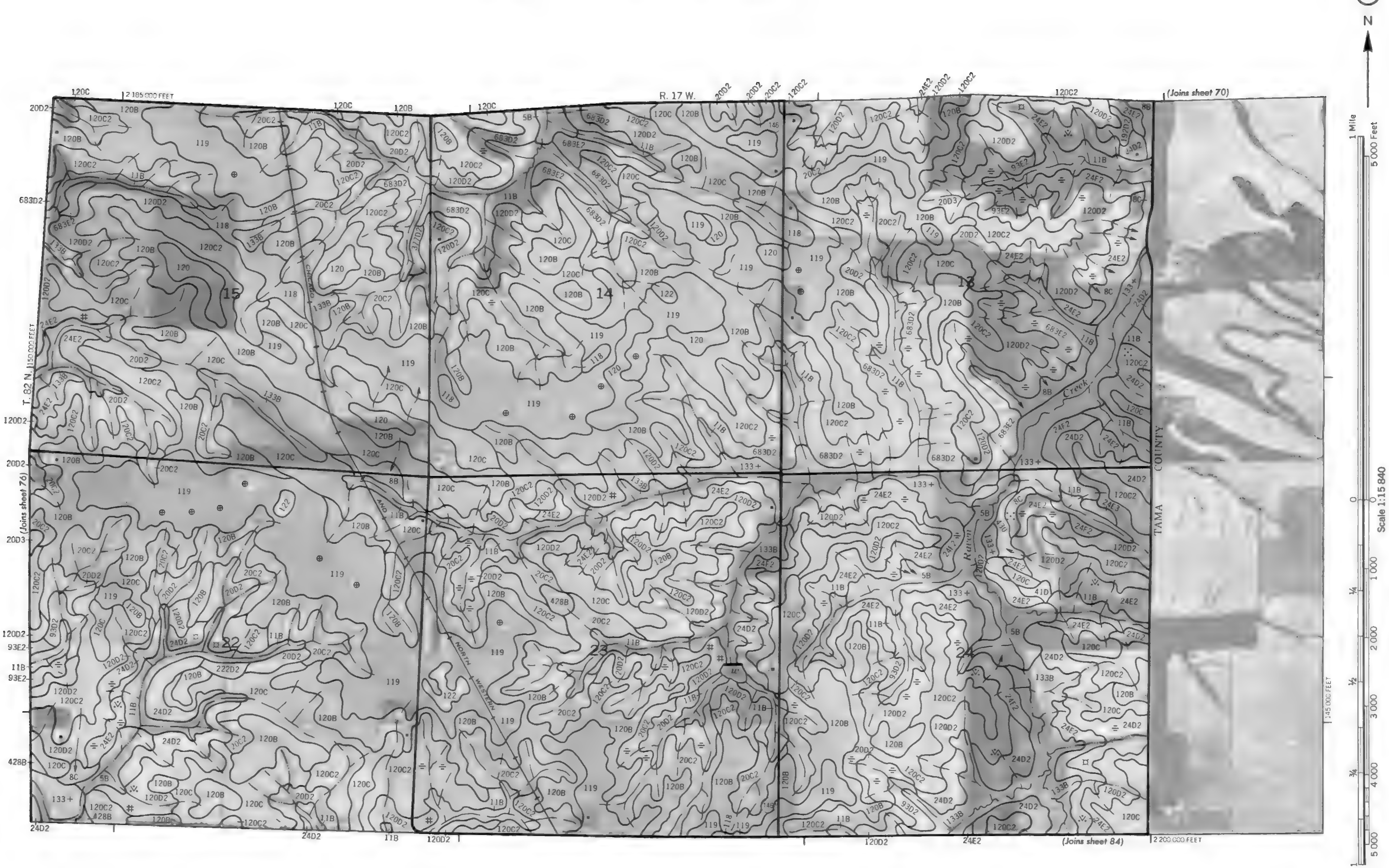


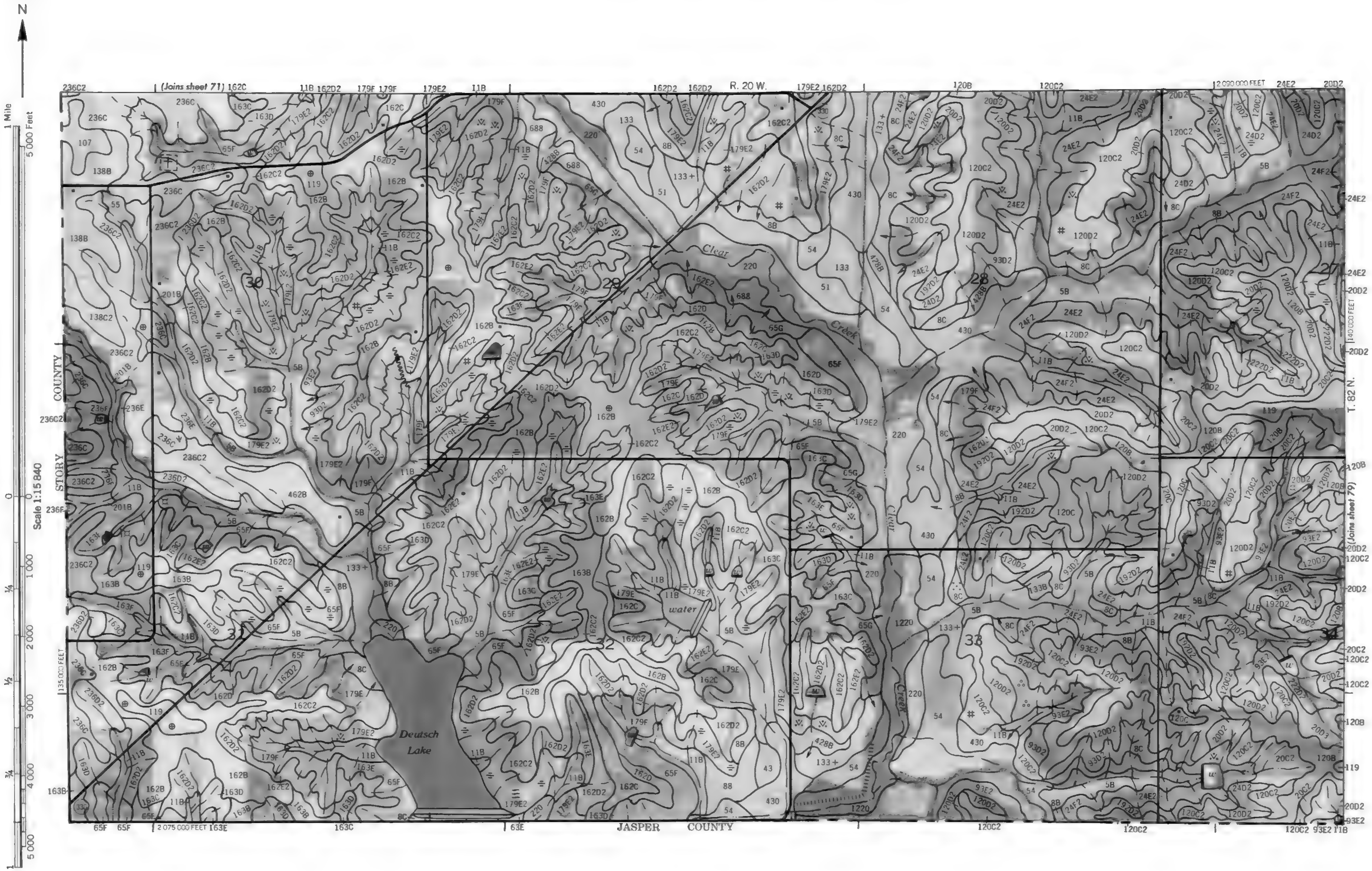
73
N
R. 19 W.
T. 82 N.
(Joins sheet 66)
(Joins sheet 74)
(Joins sheet 72)
(Joins sheet 80)
2 110 000 FEET
2 125 000 FEET
150 000 FEET
145 000 FEET
Snipe Creek
17
16
15
14
20
21
22
23
1 Mile
5 000 Feet
Scale 1:15 840

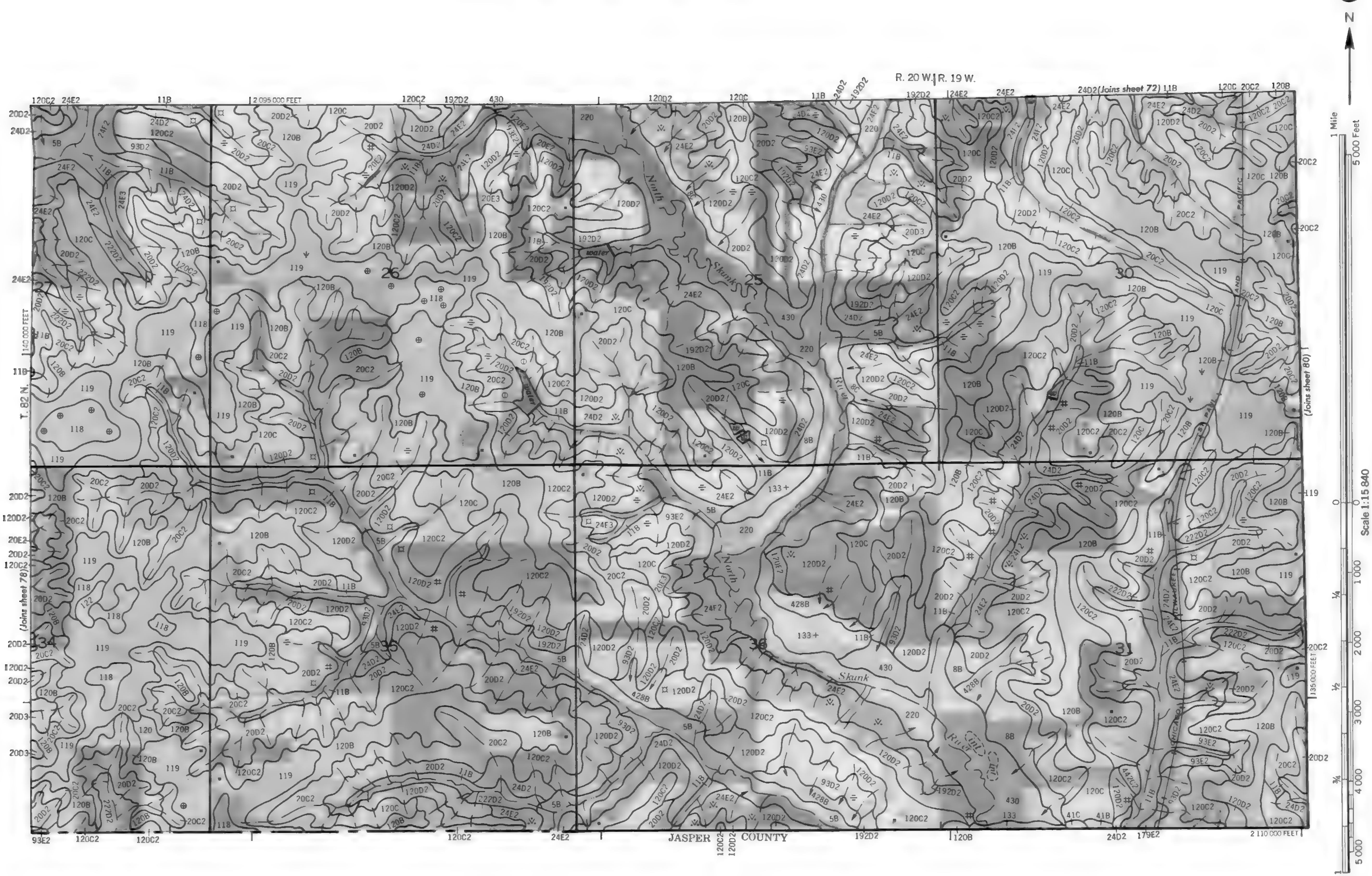

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 67)
R. 19 W.
R. 18 W.
2 145 000 FEET
(Joins sheet 73)
(Joins sheet 75)
T. 82 N.
150 000 FEET
145 000 FEET
2 130 000 FEET
(Joins sheet 81)
13
14
17
18
19
20
23
24
South
Timber
Creek

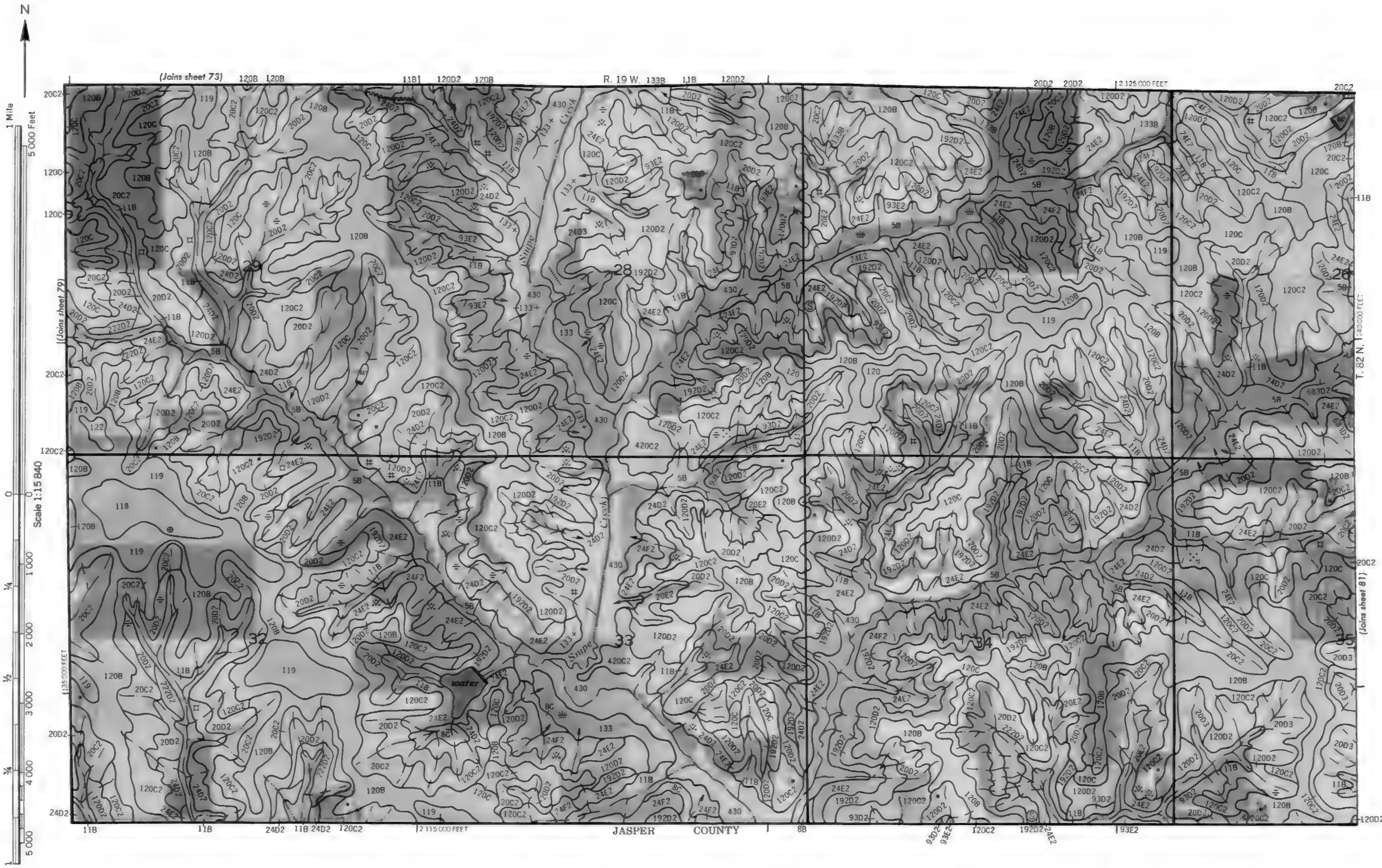

75
N
R. 18 W.
T. 82 N.
(Joins sheet 68)
(Joins sheet 74)
(Joins sheet 76)
(Joins sheet 82)
2 150 000 FEET
150 000 FEET
145 000 FEET
2 160 000 FEET
16
15
14
13
21
22
23
24
1 Mile
5 000 Feet
Scale 1:15 840

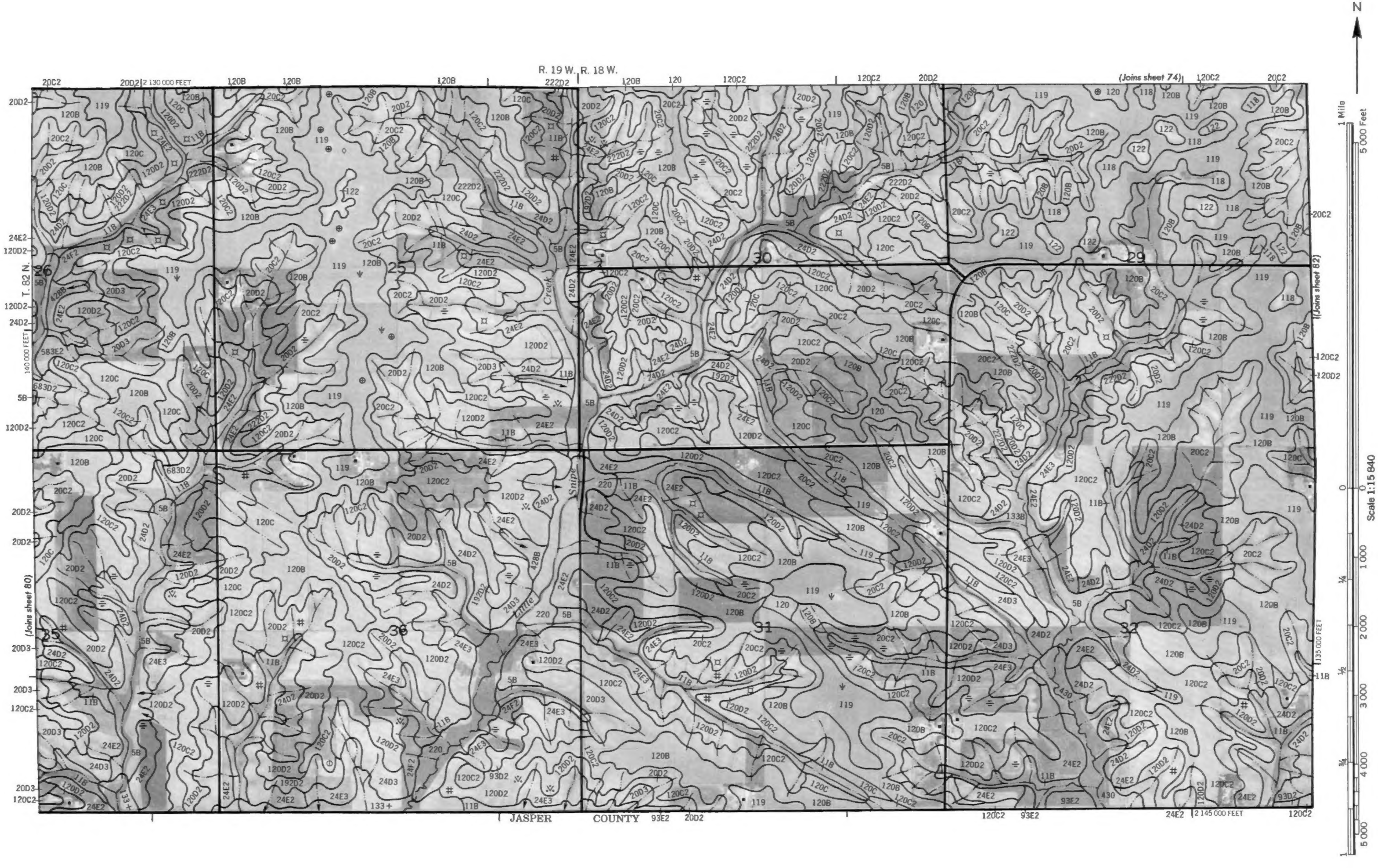

76
N
R. 18 W.
R. 17 W.
(Joins sheet 69)
(Joins sheet 75)
(Joins sheet 77)
(Joins sheet 83)
T. 82 N.
2 180 000 FEET
2 170 000 FEET
145 000 FEET
150 000 FEET
Scale 1:15 840
1 Mile
5 000 Feet
Snipe
Lutes Creek
Brush Creek
13
18
17
16
24
19
20
21

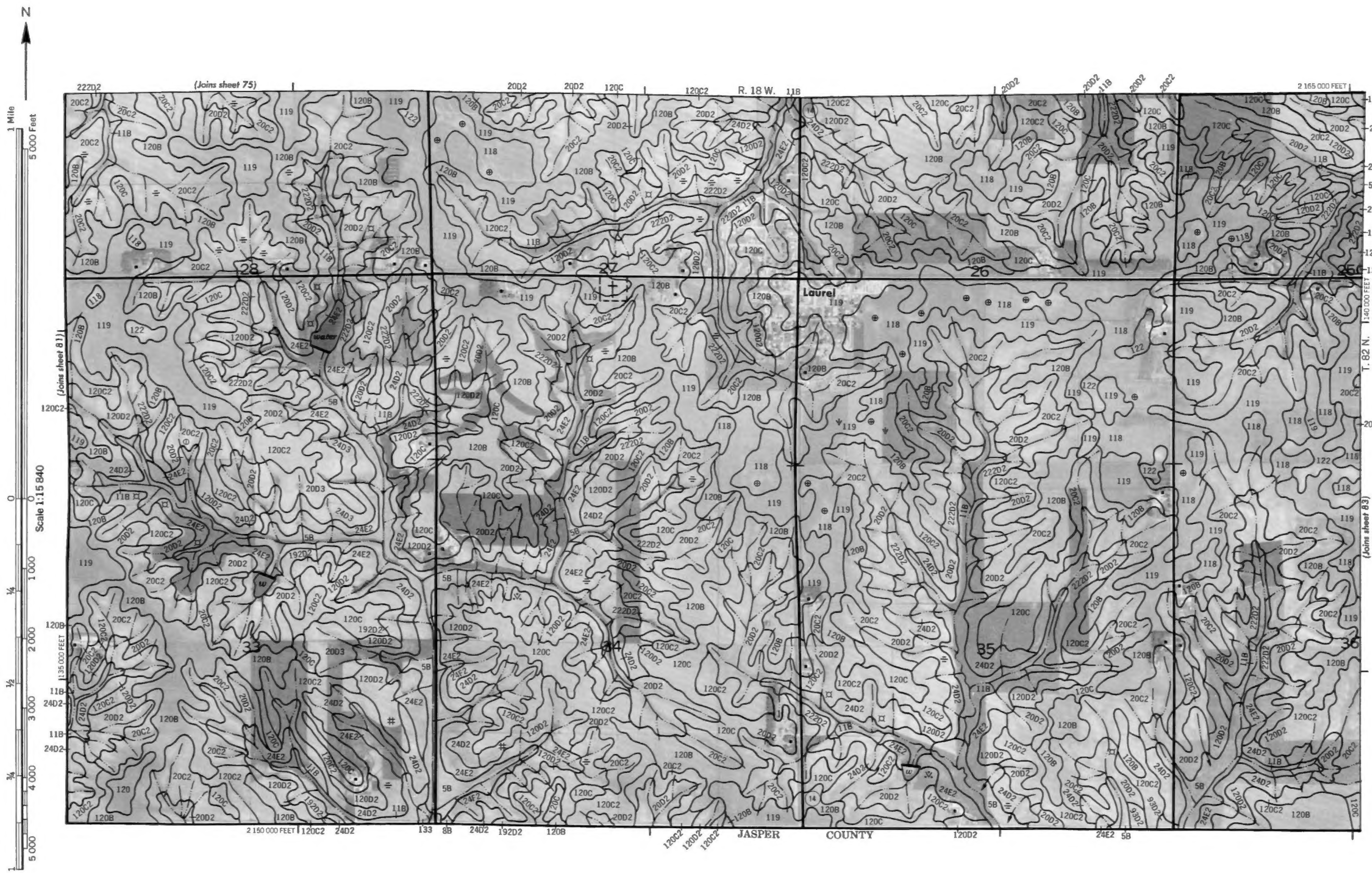

77
N
R. 17 W.
T. 82 N.
(Joins sheet 70)
(Joins sheet 76)
(Joins sheet 84)
TAMA COUNTY
CHICAGO AND NORTH WESTERN
Creek
2 185 000 FEET
2 200 000 FEET
150 000 FEET
145 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840
15
14
13
22
23
24

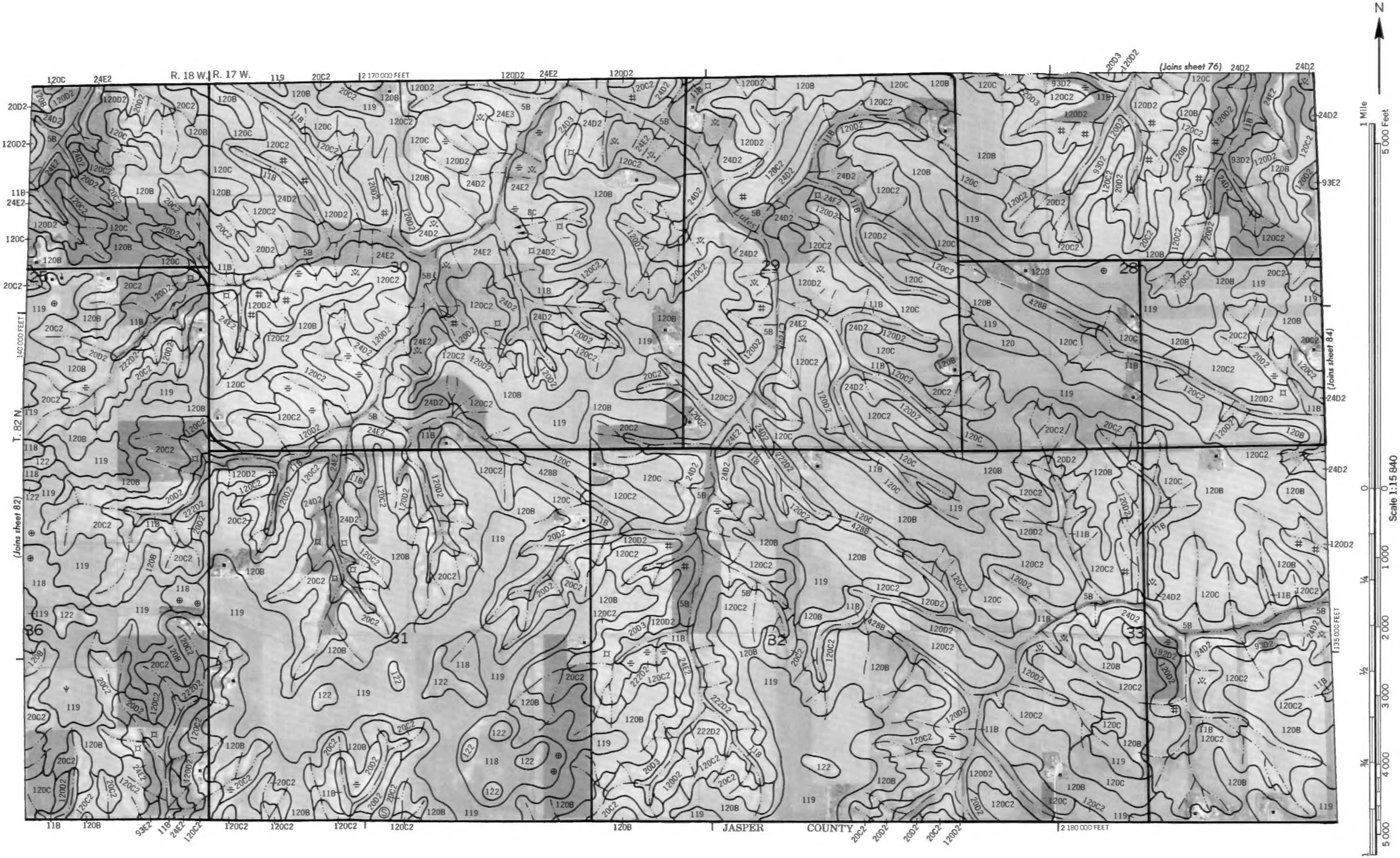

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 71)
R. 20 W.
2 090 000 FEET
T. 82 N.
140 000 FEET
(Joins sheet 79)
135 000 FEET
2 075 000 FEET
STORY COUNTY
JASPER COUNTY
Clear Creek
Clear Creek
Deutsch Lake
water
30
29
28
27
31
32
33
34

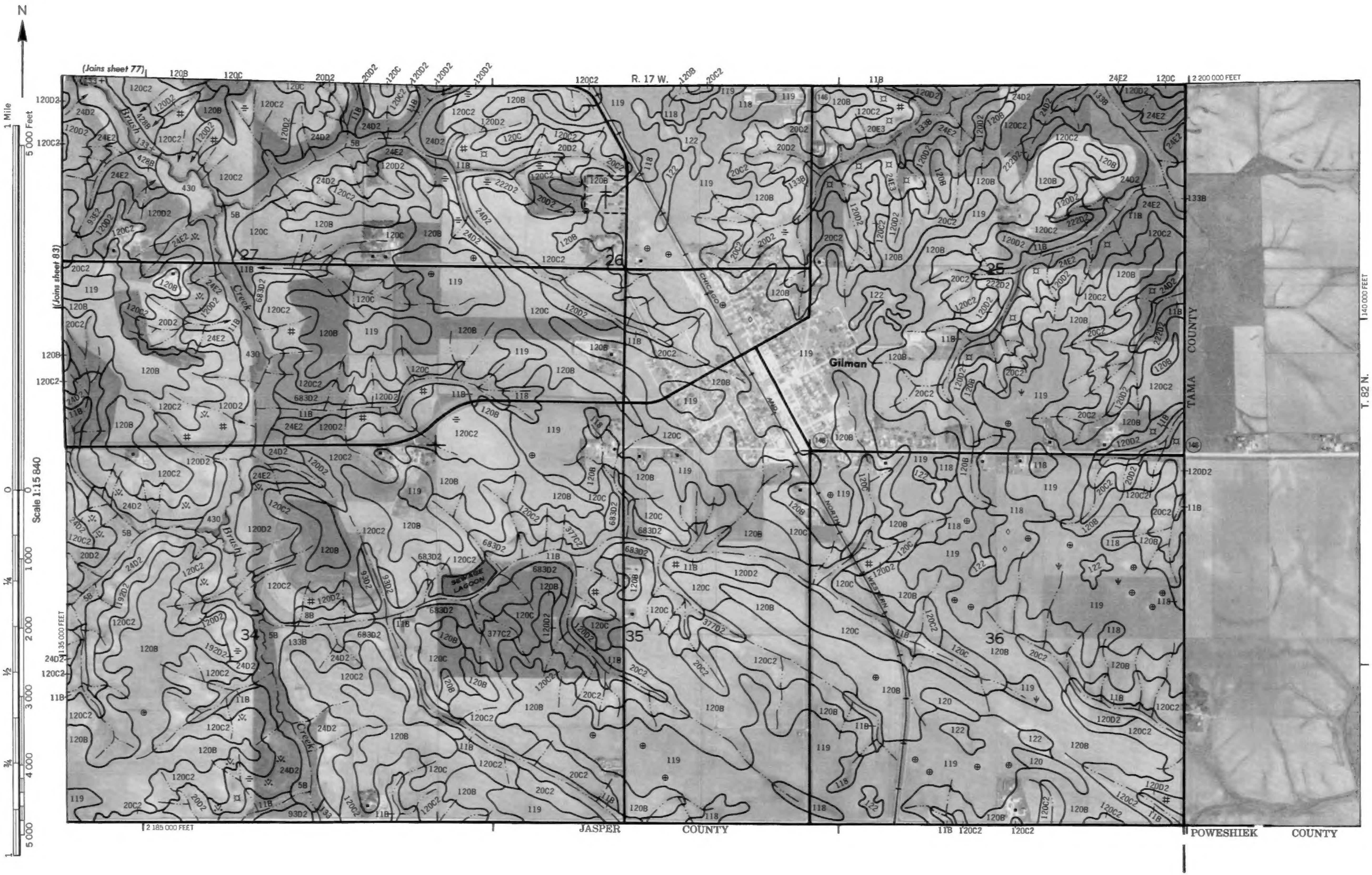

N
R. 20 W. R. 19 W.
T. 82 N.
(Joins sheet 72)
(Joins sheet 78)
(Joins sheet 80)
JASPER COUNTY
2 095 000 FEET
2 110 000 FEET
140 000 FEET
135 000 FEET
North Skunk River
26
25
30
27
34
35
36
31
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000


N
(Joins sheet 73)
R. 19 W.
2 125 000 FEET
(Joins sheet 79)
T. 82 N.
140 000 FEET
(Joins sheet 81)
135 000 FEET
2 115 000 FEET
JASPER COUNTY
Snipe Creek
water
29
28
27
26
32
33
34
35
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾


N
R. 19 W.
R. 18 W.
2 130 000 FEET
(Joins sheet 74)
(Joins sheet 82)
(Joins sheet 80)
T. 82 N.
140 000 FEET
135 000 FEET
2 145 000 FEET
26
25
30
29
35
36
31
32
Snipe
Creek
Little
JASPER
COUNTY
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾


N
(Joins sheet 75)
R. 18 W.
2 165 000 FEET
(Joins sheet 81)
(Joins sheet 83)
T. 82 N.
140 000 FEET
135 000 FEET
2 150 000 FEET
Laurel
28
27
26
25
33
34
35
36
JASPER
COUNTY
Scale 1:15 840
1 Mile
5 000 Feet


N
(Joins sheet 76)
(Joins sheet 84)
(Joins sheet 82)
R. 18 W.
R. 17 W.
T. 82 N.
2 170 000 FEET
2 180 000 FEET
140 000 FEET
135 000 FEET
JASPER
COUNTY
1 Mile
5 000 Feet
Scale 1:15 840
30
29
28
25
31
32
33
36


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 77)
(Joins sheet 83)
R. 17 W.
T. 82 N.
2 200 000 FEET
2 185 000 FEET
135 000 FEET
140 000 FEET
Gilman
Brush Creek
SEWAGE LAGOON
CHICAGO AND NORTH WESTERN
TAMA COUNTY
JASPER COUNTY
POWESHIEK COUNTY
27
26
25
34
35
36
146